Public Documents of Massachusetts:

BEING THE

ANNUAL REPORTS

OF VARIOUS

PUBLIC OFFICERS AND INSTITUTIONS

FOR THE YEAR

1904.

PUBLISHED BY THE SECRETARY OF THE COMMONWEALTH.

VOL. IV.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1905.

INDEX TO PUBLIC DOCUMENTS.

SERIES 1904.

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PUBLIC DOCUMENT . . . . No. 34.

THIRTY-SIXTH ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 Post Office Square.
1905.

APPROVED BY

THE STATE BOARD OF PUBLICATION.

MEMBERS OF THE BOARD.

1904.

HENRY P. WALCOTT, M.D., *Chairman*, ...	. OF CAMBRIDGE.
JAMES W. HULL, ...	. OF PITTSFIELD.
HON. CHARLES H. PORTER, ...	. OF QUINCY.
JULIAN A. MEAD, M.D., ...	. OF WATERTOWN.
HIRAM F. MILLS, C.E., ...	. OF LAWRENCE.
JOHN W. BARTOL, M.D., ...	. OF BOSTON.
GERARD C. TOBEY, ESQ., ...	. OF WAREHAM.

Secretary.
SAMUEL W. ABBOTT, M.D.
(Died Oct. 22, 1904.)

Engineer.
X. H. GOODNOUGH, C.E.

Pathologist.
THEOBALD SMITH, M.D.

Chief Analyst of Food and Drugs
ALBERT E. LEACH, S.B.

Chemist.
H. W. CLARK.

Consulting Chemist.
THOMAS M. DROWN, M.D., LL.D.
(Died Nov. 16, 1904.)

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GENERAL REPORT.

The following report covers the work of the State Board of Health for the year ended Sept. 30, 1904. In the field of water supply and disposal of sewage, it covers the work performed during the year ended Dec. 31, 1904; and in that of production of diphtheria antitoxin and of laboratory diagnosis, only that done during the six months ended Sept. 30, 1904, the preceding six months' work having been reported upon in the report of the Board for the year 1903. It is intended in future to report the work done by all of the departments up to a common date, namely, September 30.

As in other years, a condensed account of the work performed is given in the first part, paged in Roman numerals, and fuller details are presented in the second part, paged in Arabic figures.

In 1904 the Board comprised the following members: —

HENRY P. WALCOTT, *Chairman.*

JAMES W. HULL.	HIRAM F. MILLS.
CHARLES H. PORTER.	JOHN W. BARTOL.
JULIAN A. MEAD.	GERARD C. TOBEY.

On Oct. 22, 1904, Dr. Samuel W. Abbott, secretary of the Board, died at his home in Newton. The following tribute to his memory was spread upon the records of the Board: —

Samuel Warren Abbott, M.D., was appointed health officer of the State Board of Health, Lunacy and Charity on Dec. 2, 1882. Upon the re-establishment of the Board of Health in 1886 he was elected secretary and executive officer of the Board. Throughout all those years, and until his death on Oct. 22, 1904, he was the able, devoted and untiring officer of a service to which he gave, with enthusiasm, the best years of his life. His capacities in the preparation and discussion of vital statistics were everywhere acknowledged by the masters of the subject, and there was no department of public hygiene which had so great an attraction for him, but he neglected none of the essentials in the administration of the laws for the protection and promotion of the public health.

He gave his early years to the perilous service of his country in time of war, and spent his later years in an equally determined struggle for the safety of the lives of his fellow men.

On Nov. 16, 1904, occurred the death of Dr. Thomas M. Drown, consulting chemist of the Board, and at the regular meeting of the Board on December 1 the following tribute was presented and spread upon the records: —

Professor Thomas Messenger Drown was selected by this Board, in 1887, as the analytical chemist of the highest repute to improve known methods of analysis for determining the character of the substances present in water which may have an injurious effect upon human health, and to take charge of analyses for determining the amount of such substances in the drinking waters of the State. In the important work which the Board conducted for many years he determined the methods of analysis to be used, and taught the Board and its agents the proper interpretation of the results. He had direction and very intimate oversight of the chemical work of the Board in the original investigations upon the purification of sewage by intermittent filtration, and upon its clarification by chemical precipitation.

After becoming president of Lehigh University he continued through life the highly valued adviser of the Board in the important questions involving chemical knowledge which have been presented to it for solution, and also continued as consulting chemist of its laboratories. He appreciated the importance to the community of the work which this Board was endeavoring to perform, and entered into his part of it with an earnestness and devotion that supported and encouraged every one associated with him.

His great knowledge, his appreciation of its limitations, his clear thinking, his justness, his kindness, his sweetness rendered work with him a delight, and have contributed ennobling characteristics to the work of the Board.

On Dec. 9, 1904, at a special meeting of the Board, Dr. Charles Harrington of Boston was elected secretary, and immediately entered upon the duties of the office. During the interval between the death of Dr. Abbott and the election of Dr. Harrington, the duties of the office were performed by Dr. John W. Bartol, a member of the Board.

General Health of the State in 1904.

The number of deaths in the State in 1904 was 48,482, which was equivalent to a death-rate of 15.76 per 1,000 upon an estimated population of 3,076,083. This is less than that of any year since 1848.

The mean death-rate of the four years 1901, 1902, 1903 and 1904 was 16.26, which was much less than that of any four successive years since the beginning of registration in 1842.

The following figures are presented for the ten years ended with 1904 : —

Massachusetts.

Years.	Population.*	Deaths.	Death-rates.	Years.	Population.*	Deaths.	Death-rates.
1895, . . .	2,500,183	47,540	19.01	1900, . . .	2,805,346	51,156	18.24
1896, . . .	2,558,443	49,381	19.30	1901, . . .	2,870,710	48,275	16.82
1897, . . .	2,618,951	47,419	18.11	1902, . . .	2,937,600	47,491	16.17
1898, . . .	2,679,049	46,761	17.46	1903, . . .	3,006,040	49,054	16.32
1899, . . .	2,741,470	47,710	17.40	1904, . . .	3,076,083	48,482	15.76

* Population estimated for intercensal years.

Infectious Diseases.

The death-rate from the principal infectious diseases in 1904 was generally less than that of the previous year. There was an increase in the number of deaths from consumption, cancer and cerebro-spinal meningitis, and a decrease in the deaths from smallpox, diphtheria, scarlet fever, typhoid fever, measles, cholera infantum, dysentery, whooping-cough and pneumonia.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

Deaths and Death-rates from Certain Diseases in Massachusetts, 1900-1904.

	1900.		1901.		1902.		1903.		1904.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Smallpox,	3	.011	97	.34	284	.97	22	.07	9	.03
Diphtheria and croup,	1,475	5.26	1,166	4.06	878	2.97	869	2.89	699	2.27
Scarlet fever,	391	1.39	385	1.34	318	1.07	510	1.70	138	.45
Typhoid fever,	632	2.25	561	1.95	538	1.83	527	1.75	463	1.51
Measles,	330	1.18	173	.60	333	1.13	247	.82	160	.52
Cholera infantum,	2,398	8.53	2,705	9.43	3,157	10.75	2,469	8.21	2,297	7.47
Consumption,	5,199	18.53	5,033	17.54	4,685	15.95	4,531	15.07	4,874	15.84
Dysentery,	257	.92	223	.78	193	.66	188	.63	184	.60
Whooping-cough,	337	1.20	210	.73	337	1.15	519	1.73	117	.38
Pneumonia,	5,282	18.83	4,772	16.62	4,583	15.60	5,190	17.27	5,100	16.58
Cancer,	1,998	7.12	2,080	7.25	2,141	7.29	2,243	7.46	2,421	7.87
Cerebro-spinal meningitis,	198	.71	177	.62	165	.56	156	.52	165	.54

In the following table a balance is presented between the deaths from the principal infectious diseases in the two years 1903 and 1904, by which it appears that the sum of the deaths from these twelve causes in 1904 was less by 844 than those of 1903 from the same causes: —

Deaths from Certain Infectious Diseases in 1903 and 1904.

Diseases.	1903.	1904.	Increase.	Decrease.
Smallpox,	22	9	-	13
Diphtheria and croup,	869	699	-	170
Scarlet fever,	510	138	-	372
Typhoid fever,	527	463	-	64
Measles,	247	160	-	87
Cholera infantum,	2,469	2,297	-	172
Consumption,	4,531	4,874	343	-
Dysentery,	188	184	-	4
Whooping-cough,	519	117	-	402
Pneumonia,	5,190	5,100	-	90
Cancer,	2,243	2,421	178	-
Cerebro-spinal meningitis,	156	165	9	-
Totals,	17,471	16,627	530	1,374

Infant Mortality.

The unusually low rate of infant mortality which prevailed during the three years 1901, 1902 and 1903 was even less during the year 1904, it being 133.6 for the latter year, as compared with 139.5 for 1903, 140.4 for 1902 and 137.2 for 1901.

The total number of births which occurred during the year ended June 30, 1904, was 74,791, and the total deaths under one during the year ended Dec. 31, 1904, were 9,992.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1894, and June 30, 1895, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1904.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1895, 1896, etc. The births during these ten years were 719,683, and the deaths under one year were 106,412, which is equivalent to an infant mortality-rate of 147.9 per 1,000 births for the decade. The last half of the period shows a substantial gain over the first half, since the infantile death-rate in the last five years was 141.8 per 1,000 births, as compared with 154.1 in the first five years.

Infant Mortality, Massachusetts: 1895–1904, Ten Years.

Years.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.	Years.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.
1895, . .	66,746	10,564	158.2	1900, . .	72,430	11,500	159.0
1896, . .	70,167	11,765	167.7	1901, . .	72,559	9,952	137.2
1897, . .	72,578	10,751	148.1	1902, . .	71,770	10,075	140.4
1898, . .	73,868	11,012	149.1	1903, . .	73,618	10,269	139.5
1899, . .	71,156	10,532	148.0	1904, . .	74,791	9,992	133.6

Total births in ten years ended June 30, 1904, 719,683.
Total deaths under one in ten years ended Dec. 31, 1904, 106,412.
Mean infantile death-rate, 147.9 per 1,000 births.

Smallpox.

During the years 1901–03, smallpox became epidemic to an unusual degree, but, owing to the vigorous and painstaking measures employed, in the

year 1904 it assumed practically the conditions which prevailed in the two years immediately preceding those of the epidemic. The fatality from this disease was 9 per cent. in 1904 and 3.3 per cent. in 1903. The fatality in 1902, when the epidemic was at its height, was 11.9 per cent.

The total number of cases reported to this Board during the year 1904 was 100, and the deaths from this cause were 9. Of this number, 54 cases were those of males, with 7 deaths, and 46 were of females, with 2 deaths.

In the four years 1901–04, 3,600 cases had been reported to the State Board of Health, with 403 deaths, making a fatality of 11.2 per cent. In 1899 there were 105 cases reported, with 14 deaths, and in 1900, 104 cases, with 3 deaths; the fatality for these years being, respectively, 13.3 per cent. and 2.9 per cent.

The largest number of cases occurred during the month of September, 46 being reported for that month. Only 1 case was reported in April, and none during the months of November and December.

The following table shows the prevalence of the disease by months during the year 1904: —

	Cases.	Deaths.		Cases.	Deaths.
January,	5	1	July,	8	-
February,	5	-	August,	24	5
March,	8	1	September,	46	2
April,	1	-	October,	8	-
May,	7	-	November,	-	-
June,	3	-	December,	-	-

Of the 100 cases reported to the Board, the largest number, 61, occurred in North Adams. The following table shows the distribution of this disease among the cities and towns of the State, together with the number of deaths in each: —

	Reported Cases.	Deaths.		Reported Cases.	Deaths.
North Adams,	61	5	Adams,	3	1
Lawrence,	10	-	Monroe,	2	-
Lowell,	5	1	Beverly,	1	-
Leominster,	5	-	Gardner,	1	-
Pittsfield,	4	-	Milford,	1	-
Lee,	4	1	Totals,	100	9
Fitchburg,	3	1			

The following summary presents the number of reported cases and deaths in each year for the twenty-two years 1883–1904: —

Summary of Several Years, 1883–1904.

Years.	Cases.	Deaths.	Years.	Cases.	Deaths.
1883,	21	5	1895,	1	-
1884,	9	3	1896,	5	-
1885,	32	19	1897,	18	4
1886,	2	-	1898,	12	-
1887,	13	3	1899,	105	14
1888,	32	9	1900,	104	3
1889,	15	6	1901,	778	101
1890,	6	1	1902,	2,305	274
1891,	5	3	1903,	417	19*
1892,	19	2	1904,	100	9
1893,	45	9			
1894,	185	33	Totals,	4,229	517

* Four of these deaths, which occurred in the first days of January, 1903, were those of cases reported in December, 1902, and in reckoning the fatality of cases should be classed with the deaths of 1902.

The total number of reported cases in the twenty-two years was 4,229, and the deaths of these were 517, or 12.2 per cent.

The following table presents the data obtained from the returns received since and including 1888. The returns made previous to that date did not contain information of a sufficiently definite character to be included in this summary.

Smallpox in Massachusetts by Ages, and with Reference to Vaccination, 1888-1904.

Periods.	Vaccinated.		Unvaccinated.		Unknown.		Total.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
0-1 year,	5	-	179	45	2	-	186	45
1-5 years,	36	-	485	56	4	1	525	57
5-10 years,	36	-	267	8	9	-	312	8
10-15 years,	49	-	132	4	2	-	183	4
15-20 years,	95	3	253	17	6	2	354	22
20-30 years,	450	29	570	79	21	5	1,041	113
30-40 years,	501	43	278	55	7	1	786	99
40-50 years,	312	30	130	34	8	-	450	64
Over 50 years,	211	38	64	17	3	1	278	56
Age unknown,	14	-	12	5	10	-	36	5
Totals,	1,710	143	2,369	320	72	10	4,151	473

Following "Health of Towns," on the last pages of this report, may be found a record of visits made to cities and towns by the medical inspector for the purpose of investigating certain cases suspected of being smallpox.

Consumption.

The total number of deaths from this cause registered in 1904 was 4,874. While this was an increase of 343 deaths over the number of deaths occurring from this disease in 1903, and 189 more than occurred from the same disease in 1902, the death-rate from this cause was less than that of any year of record, except that of the previous year (1903).

The following figures present the deaths and death-rates, by ten-year periods, during the half century 1851–1900, and for the single years 1901, 1902, 1903 and 1904: —

Deaths and Death-rates from Consumption in Massachusetts, 1851–1904.

Periods.	Deaths.	Death-rates per 10,000.	Periods.	Deaths.	Death-rates per 10,000.
1851–60,	45,252	39.9	1901,	5,033	17.5
1861–70,	45,913	34.9	1902,	4,685	15.9
1871–80,	54,089	32.7	1903,	4,581	15.1
1881–90,	58,303	29.2	1904,	4,874	15.8
1891–1900,	54,374	21.4			

Typhoid Fever.

The following table presents the deaths and death-rates of these cities from this cause during the four years 1901–1904: —

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1901–1904.

Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.	Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.
North Adams,	39	3.6	Brockton,	26	1.5
New Bedford,	87	3.3	Beverly,	9	1.5
Newburyport,	19	3.3	Melrose,	8	1.5
Pittsfield,	26	2.9	Worcester,	67	1.3
Salem,	41	2.8	Somerville,	35	1.3
Chelsea,	37	2.6	Everett,	15	1.3
Waltham,	25	2.5	Cambridge,	47	1.2
Malden,	34	2.4	Holyoke,	24	1.2
Lawrence,	62	2.3	Fitchburg,	16	1.2
Boston,	517	2.2	Medford,	9	1.1
Springfield,	56	2.1	Northampton,	9	1.1
Lowell,	79	2.0	Quincy,	10	1.0
Fall River,	81	1.8	Newton,	14	0.9
Lynn,	51	1.8	Marlborough,	4	0.8
Haverhill,	28	1.8			
Gloucester,	18	1.8	Total,	1,539	-
Taunton,	23	1.7			
Woburn,	10	1.7	Mean annual death-rate,	-	1.9*
Chicopee,	13	1.6			

* Calculated from estimated mean annual population of the foregoing cities for the four years 1901–04 of 2,008,553.

By the foregoing table it appears that the death-rate from this cause during the four years 1901–04 was 1.9 per 10,000. By comparing this rate with the following condensed summary from the report of 1900 it can be seen that a decided and continuous improvement is taking place.

Death-rates from Typhoid Fever per 10,000, 1871-1904, Massachusetts.

1871-75,	8.2	1891-95,	3.4
1876-80,	4.2	1896-1900,	2.6
1881-85,	4.1	1901-04,	1.9
1886-90,	4.6		

For the entire State the death-rates from this cause in 1901, 1902, 1903 and 1904 were, respectively, 1.95, 1.83, 1.75 and 1.75 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in North Adams (3.6), New Bedford (3.3) and Newburyport (3.3); and the lowest occurred in Quincy (1), Newton (.9) and Marlborough (.8). Marlborough reported only 4 deaths from this cause in the four years.

Diphtheria.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1900 and for the single years 1901, 1902, 1903 and 1904: —

Deaths and Death-rates from Diphtheria per 10,000, 1876-1904, Massachusetts.

Years.	Deaths.	Death-rates.	Years.	Deaths.	Death-rates.
1876-80,	13,676	15.8	1901,	1,166	4.1
1881-85,	8,944	9.5	1902,	873	3.0
1886-90,	8,857	8.4	1903,	869	2.9
1891-95,	7,652	6.4	1904,	699	2.3
1896-1900,	6,331	4.7			

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

Other Preventable Diseases.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum and whooping-cough, for the period of thirty-five years, 1866–1900, and for the four years 1901, 1902, 1903 and 1904: —

Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infectious Diseases by Five-year Periods, 1866-1900, and for 1901-04.

	Measles.		Scarlet Fever.		Dysentery.		Cholera Infantum.		Whooping-cough.	
	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.
1866-70, . .	1,081	1.6	4,670	6.8	3,244	4.7	6,943	10.1	1,481	2.1
1871-75, . .	1,133	1.4	6,782	8.6	2,191	2.8	12,458	15.8	1,561	2.0
1876-80, . .	742	0.9	3,517	4.1	2,366	2.7	9,054	10.5	1,498	1.7
1881-85, . .	1,007	1.1	2,504	2.7	1,601	1.7	9,894	10.5	1,213	1.3
1886-90, . .	1,089	1.0	1,810	1.7	1,276	1.2	10,904	10.3	1,421	1.3
1891-95, . .	815	0.7	2,857	2.4	1,083	0.9	13,426	11.2	1,445	1.2
1896-1900, . .	948	0.7	1,358	1.0	1,434	1.1	11,865	8.9	1,465	1.1
1901, . . .	173	0.6	385	1.3	223	0.8	2,705	9.4	210	0.7
1902, . . .	333	1.1	313	1.1	198	0.7	3,157	10.7	337	1.1
1903, . . .	247	0.8	510	1.7	188	0.6	2,469	8.2	519	1.7
1904, . . .	160	0.5	138	0.5	184	0.6	2,297	7.5	117	0.4

The deaths from cerebro-spinal meningitis were 165, which were 9 more than occurred in the preceding year, and represented a death-rate of .5 per 10,000 living.

There were 2 deaths from glanders during the year and none from hydrophobia.

Water Supply and Sewerage.

During the year, the Board received 125 applications for advice upon matters relating to water supply, sewerage and sewage disposal, — about the same number as in the previous year. The number includes also those cases in which the specific approval of plans of water supply and sewerage systems, or of the taking of lands for these purposes, is required by special acts of the Legislature, or votes of city or town governments. Of the 125 applications received, 74 related to water supply, 12 to sources of ice supply, 30 to sewerage, drainage and sewage-disposal systems, and 9 to miscellaneous matters, including the prevention of pollution of streams and tidal waters.

Examination of Water Supplies.

A public water supply was introduced during the year in the town of Ashfield, and at the end of the year, 172 of the 353 cities and towns in the State were provided with public water supplies. These 172 cities and towns contain approximately 92 per cent. of the population of the State. All of the cities and towns of the State having a population, according to the census of 1900, in excess of 3,500 are now provided with public water

supplies, except the towns of Barnstable, Blackstone, Chelmsford, Dartmouth, Dudley, Pepperell and Tewksbury.

Many of the sources of public water supply were inspected during the year by the engineer of the Board or his assistants, and the waters of 210 sources were examined at regular intervals by means of chemical analyses. Microscopical and bacterial analyses also have been made in some cases. The results of the examinations of water supplies are presented on pages 109 to 176 of this report. The tables of analyses made during the year, as usually given in previous reports, are omitted, and the results of examinations made during the past five years have been summarized, and are presented in general tables so arranged as to afford a means of comparing the various waters as to their sanitary condition and the various properties usually considered in determining the quality of a drinking water. The usual tables of water supply statistics are presented on pages 183 to 192.

Rules and Regulations for preventing the Pollution and securing the Sanitary Protection of Waters used as Sources of Public Water Supply.

In response to the petitions of the authorities of the cities of Worcester, Northampton and Springfield, and the towns of Plymouth, Greenfield, Easthampton, Wakefield, Randolph and Holbrook, the Board has established rules and regulations for preventing the pollution and securing the sanitary protection of the ponds and streams used by those municipalities as sources of public water supply. The rules and regulations are similar to those which have been adopted by the Board in previous years for the protection of the waters of other cities and towns.

Experiments upon the Application of Salts of Copper to Ponds and Reservoirs, to destroy Growths of Organisms.

One of the most serious annoyances to which the users of water drawn from ponds and reservoirs are subjected is the disagreeable taste and odor by which the water of many of these sources is at times affected, — an annoyance which has been sufficient in some cases to lead to the abandonment of the source of supply.

The objectionable tastes and odors of pond and reservoir waters, which are often attributed to decaying fish and other causes, are, in practically all cases which have been brought to the attention of the Board, caused by the presence of organisms, in some cases of kinds which attach themselves to the sides and bottom of the reservoir, but in the majority of cases of those kinds which live in suspension in the water. Early in 1903, Dr. George T. Moore, algologist of the United States Department of Agriculture, brought to the attention of the Board the results of investigations which he had made, indicating that the microscopic organisms which are the chief cause of objectionable tastes and odors in the waters of ponds and

reservoirs could be destroyed by applying sulphate of copper, or blue vitriol, to the water in very small quantities; and information was also submitted tending to show that bacteria were also destroyed in water brought in contact with metallic copper. Experimental tests of the applicability of the use of sulphate of copper as a method of removing growths of organisms, and the objectionable conditions which they cause, as suggested by Dr. Moore, were begun at once. Salts of copper are nearly all soluble in water, and are regarded as poisonous when used in food preparations; it is obviously necessary, under the circumstances, that these substances should not be deposited in water used for drinking purposes until their probable effect upon the condition of the reservoir, and especially upon the health of those to whom the water is being supplied, has been definitely determined. Fortunately, a considerable number of ponds and reservoirs formerly used as sources of water supply, but now abandoned, were found to be available for experiment; and in the use of these reservoirs there was the advantage that their biological history had been observed during the period of their use as sources of water supply, and that these records were available for use in determining the changes resulting from a treatment such as that proposed.

Two of these sources were treated with copper sulphate in 1903, the quantities applied amounting to from 1 part in 1,500,000 to 1 part in 2,000,000 parts of water; and during 1904 further experiments have been carried on with these and other reservoirs. The application of copper sulphate has been made in all cases under the direction of Dr. Moore, and the effect of the treatment upon the chemical and biological condition of the water has been determined by analyses of samples collected before and after the treatment.

One of the matters of greatest importance in connection with the possible use of copper sulphate for the removal of growths of organisms from public water supplies is to determine what becomes of the copper deposited in the water, and many experiments have been made to determine its final disposition. Experiments are also being made to determine the effect of this form of treatment upon animal life of various kinds.

The results of some of the experiments and investigations so far as obtained tend to support the conclusions which had been reached when the matter was first brought to the attention of the Board as to the practicability of the copper treatment for the removal of growths of organisms and bacteria, but the results of other experiments conflict with some of these conclusions. Further study and experiment are necessary before the probable results of the use of copper in preventing objectionable conditions resulting from growths of organisms, or the probable effect of the use of this substance in public water supplies upon the public health, can be conclusively determined.

The Lawrence City Filter.

The Lawrence city filter, constructed for the purpose of purifying the sewage-polluted water of the Merrimack River and preventing the excessive death-rate from typhoid fever and other diseases resulting from the use of a polluted water supply, was constructed by the city under the advice of this Board in 1893. How successfully it has served its purpose is shown by the great reduction in the death-rate of the city in the years following the completion and use of the filter, as compared with the preceding years.

The filter was designed to be of sufficient capacity for the needs of the city at the time it was built; but the original design, which included a cover or roof to protect the filter in winter, was not carried out, and its operation has been greatly hampered and its capacity limited on account of the impracticability of maintaining its surface in proper condition in cold weather. In the winter of 1901–02, the consumption of water in the city was for a period of several days greater than the capacity of the filter; and for a period of many days in that winter the water stored in the distributing reservoir was very nearly exhausted. Early in the spring of 1902, the Board advised the city of the urgent need of covering the filter, thus relieving it from obstruction from ice and snow and freezing weather, and to provide as soon as practicable an additional filtering area; but the only action taken by the city authorities was to divide the filter into three parts, by means of walls, by which a very little improvement was made in the operation of the filter. The winter of 1902–03 being a very mild one, enough water was obtained for the supply of the city. Nothing was done in the summer season of 1903 toward enlarging the works for supplying filtered water to the city or pure drinking water from any other source, though in the month of December plans for a new filter were finally submitted to and approved by the Board. In the winter of 1903–04 the distributing reservoir again became very nearly exhausted, so that, if a large fire or an accident to the works had occurred, it would have been necessary to introduce the sewage-polluted water of the Merrimack River directly into the city's supply mains. During the past summer, also, nothing has been done by the city to avert the calamity of introducing the unfiltered Merrimack River water, from which the city has twice barely escaped. The responsibility for the present conditions appears to rest upon the city government, which, in spite of the warnings given, has not seen fit to make provision for protecting the lives and health of the people of the city from the danger to which they are now exposed.

Examination of Sewer Outlets and the Effect of Sewage Disposal.

The examinations of sewer outlets during the past year have been directed chiefly to the outlets into Boston harbor, and to investigations of the conditions of flats and tidal waters from which shellfish are taken for food.

On April 28, a communication was received from the city of New Bedford, requesting advice as to whether clams and quahaugs collected from the Acushnet River could safely be used for food; and in response to this request the Board examined the conditions of the flats and tidal waters about the city of New Bedford and the places from which shellfish were being collected, and caused numerous bacterial examinations to be made of the shellfish collected from the flats and waters about the city. The results of the investigations showed that the sewage from a part of the city of New Bedford was being discharged into New Bedford harbor through twenty-six sewer outlets, and that there were six sewer outlets discharging into Clark's Cove, an arm of the sea south of the city. The sewage of the town of Fairhaven, situated opposite New Bedford, is also discharged into New Bedford harbor. The great bulk of shellfish collected from the waters about New Bedford are taken from New Bedford harbor, and the observations made by the Board show that a large proportion were collected from the New Bedford side of the harbor, often within 400 feet of the shores in front of the sewer outlets. Numerous samples of quahaugs collected from all over the harbor have been analyzed by the Board, and a large proportion of them were found to show the presence of sewage bacteria. Shellfish are also collected all about the upper end of Clark's Cove, and examinations of samples from this locality have shown that a large percentage are affected by sewage.

Since it was evident, from these examinations and investigations, that shellfish taken from these localities were likely to injure the health of those who might use them for food, the Board deemed it necessary that the further taking of shellfish from these waters should be prevented; and therefore brought the matter to the attention of the Commissioners on Inland Fisheries and Game, and requested that commission, under the provisions of section 113 of chapter 91 of the Revised Laws, to prohibit the taking of shellfish from the waters of New Bedford harbor north of or inside of a line drawn from Fort Point in Fairhaven to a point on the easterly shore of Clark's Point one mile south of the most southerly sewer outlet in the city of New Bedford, or from the waters of Clark's Cove at any place within three-quarters of a mile of the outlet of any sewer of the city of New Bedford discharging into Clark's Cove; and a chart showing the areas from which the taking of shellfish was prohibited was sent to the commission.

Examination of Rivers.

A report on the rivers affected by sewage pollution which have been under observation during the year, together with a summary of the results of the various analyses showing the condition of the Blackstone and Merrimack rivers, will be found on pages 177 to 182.

The Neponset River.

The most serious sources of pollution of the Neponset River in Norwood and Walpole above the Great Meadows are caused by the wastes from the sewer of the town of Norwood and the wastes from a tannery, two paper mills and a gas works. Plans for the purification of the town sewage and the tannery wastes have been submitted to and approved by the Board; and during the past year notice has been given to the authorities of the town and the owners of the tannery to discontinue the discharge of unpurified sewage and wastes into the river after July 1, 1905.

Plans for the disposal of the wastes of three other works have been submitted for the approval of the Board, and the owners of other large works have notified the Board of their intention to present plans for the purification of their wastes at an early date. The quantities of water used in some of these works and seriously polluted in the various processes are very large, and it is essential that these waters should be returned to the stream, after purification, for the use of other owners below. Under these circumstances the problem of satisfactorily purifying these wastes is in many cases a serious one, requiring a careful study of the methods proposed, in order to secure satisfactory results.

Investigations upon the Purification of Sewage and Water at the Lawrence Experiment Station.

In sewage filtration, especial attention has been given during the past year to intermittent sand filters, which have been in operation for many years at the Lawrence Experiment Station. Efforts have been made during the year so to operate these filters that the organic matter which has accumulated upon the sand may be removed by bacterial action, and increased efficiency be thereby obtained.

This study has given rise to various other special lines of work on the varied character of organic matter stored in sewage filters and its degree of stability and resistance to bacterial oxidation; and in connection with this work, experiments have been made to determine the degree of acidity or alkalinity of the effluents of sewage filters of different kinds when they are effecting the highest degree of purification.

The investigations as to the operation of septic tanks and the efficiency of contact and the intermittent continuous filters have been continued as in

the previous year, and the filters used in testing the results of these methods of sewage purification have been constructed of different materials and operated at various rates. Investigations have also been made as to the kinds of bacteria in sewage, and their functions in the process of sewage purification. A new method of determining the degree of turbidity in water, especially in the effluents from sewage filters, has been worked out at the experiment station during the year, this method giving a much better idea of the actual amount of mineral and organic matter present in the water as suspended matter or sediment than the method hitherto used.

The experiments upon the filtration of water have been continued as in previous years, special attention being given to the results obtainable by rapid filtration, aided by coagulants, and by double filtration, in order to determine the efficiency of such methods.

Investigations have been made during the year at the experiment station upon the bacterial examination of shellfish affected by sewage pollution, to determine the length of time the dangerous organisms may live in shellfish under various conditions, and the degree of heat necessary in cooking to destroy pathogenic bacteria. Much work has been done at the experiment station, as already indicated, in the study of the effect of copper sulphate and metallic copper upon microscopic organisms and bacteria.

The results of the experiments are presented on pages 195 to 295.

Food and Drug Inspection.

The work of the State Board of Health in the inspection of food and drugs during the year ended Sept. 30, 1904, will be found reported upon pages 297–345. This work was entrusted to the State Board of Health by a statute enacted in 1882 (chapter 263 of the Acts of that year), and has been conducted continuously under the supervision of the Board since that year.

Primarily the work is conducted as a system of inspection, the samples obtained for analysis being purchased in open market in the same manner as such articles are commonly purchased by the consumers. Provision is also made for the examination of articles of food or drugs under proper conditions, which are brought to the office for examination by citizens. This, however, does not include the examination of products intended for sale by dealers or manufacturers or producers, when such examination may be used for advertising purposes.

The number of samples of food and drugs examined by the analysts of the Board during the year ended Sept. 30, 1904, was 8,651, the total number for the whole period of work since 1883 being 157,356.

The number of prosecutions during the year was 62, and the whole number for the whole period of work was 1,788. The detailed account of the prosecutions was sent to the Legislature in January, 1905, and is also published in this report.

The inspection of liquors has included the examination, by the analysts of the Board, of samples sent in for analysis by police officers, or because of the supposed existence of harmful adulterants. During the year ending Dec. 31, 1904, 283 samples of liquor were sent in for analysis by chiefs of police and other officers, and, of the cases in which the liquor was sold in no-license towns and contained more than 1 per cent. of alcohol, a large proportion were prosecuted.

Investigation of the Sanitary Conditions of Factories, Workshops and Other Places of Employment in the Commonwealth.

The following resolve was enacted by the Legislature at the session of 1904: —

[Chapter 99, Resolves of 1904.]

Resolve to provide for an Investigation as to Sanitary and Other Conditions affecting the Health or Safety of Employees in Factories and Other Establishments.

Resolved, That the state board of health, with such aid as it may require from the chief of the district police and the bureau of statistics of labor, is hereby directed to investigate the sanitary conditions of factories, workshops and other places of employment in the Commonwealth of Massachusetts, with respect to all conditions which may endanger the life and limb or be prejudicial to the health of the persons employed therein. The officers and employees of said board shall have power to enter and inspect all premises in use for industrial purposes and to obtain such information as may be necessary for carrying out the purposes of this resolve. The board may expend a sum not exceeding one thousand dollars in carrying out the provisions of this resolve, and is directed to report to the next general court on or before the fifteenth day of January next, and shall accompany its report with such recommendations as it deems advisable. [*Approved June 3, 1904.*]

Under the terms of this resolve, the following report was prepared for the Legislature of 1905, and was forwarded in due course: —

In the study of the relations of industrial conditions to health, it is very essential to success not to give more than due weight to the results of analysis of mortality returns, which, unless proper allowance is made for various important factors, may lead to very fallacious results. The complete dissociation of the influence of these factors is, in any extensive inquiry, quite beyond the range of possibility; but with due consideration of the differences existing in the conditions which attend different callings, many valuable inferences can be drawn. Due weight must be given to the fact that, while certain occupations are open only to the strong and intelligent, others are the refuge of the weak and ignorant. Some of the callings recognized as dangerous fail to attract the better element of the working classes, in spite of a high rate of wage; while others of the same class, conducted under proper hygienic supervision, may attract the same class in spite of a comparatively low rate. The extramural conditions also are of the highest importance, whatever be the nature of the calling. In the same line of work, those who are properly housed, fed and clothed, and whose mode of life is

marked by temperance in all things which may influence health, will show a smaller percentage of sickness, a lower death-rate and a higher average age at death than those whose home surroundings are inferior or bad, and whose lives are marked by vicious excesses. Again, age is an important factor. In certain lines of industry that offer but a low wage, it is largely the very young, not yet arrived at full development, who respond to the call; and if the particular industry be one of those classed as dangerous, the inevitable result of non-observance or non-provision of necessary hygienic precautions is a high rate of morbidity and mortality and a low average age at death.

The callings which are most likely to exert an injurious influence on any class of persons are those conducted indoors, and especially those which involve exposure to poisonous substances of a gaseous nature and to irritating and poisonous dusts. In all of the industries which properly are regarded as dangerous, the operatives themselves are commonly very largely to blame for the harmful results generally recognized, because of their disregard of proper hygienic precautions which can easily be observed. It is a notorious fact, for example, that workers exposed to dust are generally disinclined to use respirators designed to prevent its inhalation, and are averse to the use of hoods and fans which are set in place for its proper removal, if it happens that these devices interfere in any degree with the supply of light; and that those whose hands come in contact with poisonous substances, such as lead and lead compounds, are commonly prone to neglect the simple precaution of cleansing their hands thoroughly before handling their noonday food. It is to be said, however, in justice to those who decline to use respirators, that most of these contrivances cause marked discomfort, becoming wet with the condensed aqueous vapor of the respired air, causing some difficulty in breathing and promoting local perspiration.

The subject of occupational hygiene being so very broad and complex, it is plain that, within the brief period allowed and within the limits of the appropriation made for such an extensive inquiry, definite results can be obtained only within very narrow bounds; and that the most useful results would follow an effort to investigate the conditions inseparable from or incident to a few of the more dangerous of the processes pertaining to some of the important trades and industries, and to localize the specific causes of ill-health among the operatives engaged therein.

Under existing laws, the district police have a definite line of sanitary work to perform in the inspection of the ordinary sanitary provisions which should exist in all factories, such as the condition of water-closets, ventilation, drainage, etc.; and hence it would appear that the broader duty of investigating the specially injurious conditions peculiar to the different lines of industry was the important and essential part of the work imposed upon the Board, and it was decided to confine the inquiry chiefly to a number of those industries involving exposure to dust and to other substances of a poisonous nature. This selection was influenced mainly by the fact that the inhalation of dust predisposes to the development of diseases of the lungs, especially of pulmonary consumption, and by the additional fact that this danger can be obviated in large part by the observance of precautionary measures.

That the leading causes of death in this and other countries are diseases of the lungs, is too well known to need more than passing mention. The sanitary authorities of all civilized countries view the enormous death-rate from con-

sumption with grave concern; and the study of methods for its reduction is engaging widespread attention, not alone of the medical profession, but of thinkers in every walk of life. That industrial conditions are largely responsible for its spread has been recognized ever since the beginning of the systematic study of occupational hygiene, more than two centuries ago; and it has long been known that the disease is much more prevalent among the followers of certain callings which involve confinement in a dusty atmosphere than among those whose work involves no such exposure. Since the discovery of the specific cause of the disease in 1882, and the method of its dissemination from the sick to those who are susceptible, it has become more and more evident that, in confined spaces, the presence of consumptives is a menace to the health of their associates, even though the habit of indiscriminate spitting be not indulged in. The spitting consumptive is naturally a far greater menace, since his sputum contains the exciting cause of the disease in great numbers, and when dried and pulverized it becomes disseminated in the form of infectious dust. The inhalation of irritating dusts of various kinds leads to local changes in the mucous surfaces of the respiratory tract, and thus enables the specific germ to establish a foothold in the systems of those whose lowered vitality has made them susceptible to attack. It is obvious, therefore, that a due regard for the health of those exposed to industrial dusts demands that this source of danger should be reduced as much as possible by the application of all reasonable sanitary measures. Students of industrial hygiene are substantially agreed on the general proposition that there is scarcely a dangerous trade which cannot be made safe by the exercise of extreme care and attention to proper sanitary regulations.

In the beginning of this investigation it was hoped that valuable data might be secured from a study of the records of the State Sanatorium at Rutland. Examination showed, however, that of a large number of patients who had followed trades which commonly are classed as dangerous to health, no less than 46.35 per cent. belonged to families which had a tubercular history, one or more members having died of the disease. It is naturally impossible in these cases to determine whether the patient acquired the disease as an accident of his calling, or in consequence of daily contact with a sufferer at home.

A study of the causes of deaths reported from several of the industrial centres to the office of the Secretary of State has yielded certain facts which have an apparent value, and these will be found below in the consideration of some of the various trades which have been investigated.

In the report below, of observations made in the various establishments visited, on account of the fact that time and expense did not permit of anything like an investigation of the conditions obtaining in all of the plants of each industry within the Commonwealth, no names will be given, and thus no charge of invidious distinction can be laid.

In the investigation of the industries selected, some forty cities and towns were visited and more than one hundred factories were examined. These included cutlery and tool factories, stone-cutting establishments, cigar factories, shoe factories, cotton, woolen and silk mills, in all of which industries the evolution of dust is an incident of greater or less importance; rubber factories, white lead works and lead pipe works, in all of which the possibility of lead poisoning is one of the dangers to be considered; bakeries, laundries, curled-hair factories, straw shops, and miscellaneous others of lesser importance.

The Cutlery and Tool Industry.

In the manufacture of cutlery and tools, the most important of the processes from a hygienic point of view are those of wet and dry grinding and burnishing. In the operation of wet grinding, each operative reduces to their proper shape and size a certain number of pieces per day, using for the purpose large grindstones run by power. This process being completed, the articles are ground farther on other finer stones, or "whitened." Next, they are taken to the dry-grinding room, where they are farther subjected to the action of emery and corundum wheels, and finally they are polished on buffing wheels. In all of these processes, even in the wet grinding, a large amount of exceedingly irritating mineral and metallic dust is given off; and in properly equipped establishments provision is made for its speedy removal by means of hoods and exhaust fans or blowers. In five of the fifteen establishments visited there was a proper equipment of fans and but little dust; in three, the hoods had been partly or wholly removed, on account of interference with light; in one, the fans were mostly without hoods and the rest were inefficient; in three there were no fans whatever; and in the remainder there were fans which were only partly efficient. In one of the dry-grinding rooms a consumptive was employed, with no precautions whatever against possible contamination of the air by his dried expectorations.

The occupation of cutlery grinding is justly regarded as one of the most dangerous of callings. The average age of operatives at death is exceedingly low, and in establishments conducted without proper hygienic precautions, sound men are rare after a few years' work. The prevailing cause of death is consumption, which usually overtakes a susceptible worker so early that his period of usefulness does not extend much beyond five or six years, excepting in factories where the health of the workmen is properly safeguarded. Interviews with physicians having large practice among cutlery employees bear out these statements. One physician stated that nearly all who reach the age of forty die of tuberculosis, excepting those who succumb to some acute disease. Another, located in another industrial centre, has noticed a falling off in the incidence of the disease during the past ten years, due to the better care of the workmen and to improved conditions at the factories. Others state that consumption is far more common among grinders than among any other class with whom they have to deal. The death returns for the past five years from Northampton and Montague, two of the most important seats of the cutlery industry, offer some interesting facts. In Northampton the death-rate from tuberculosis for the entire male adult population for five years was 2.9 per thousand, while that for the cutlers was no less than 11.8 per thousand, or four times as great. In Montague the five-year rates for the two classes were, respectively, 2.6 and 8 per thousand.

From the investigations made, the conclusion must be drawn that in a certain proportion of the establishments visited exceedingly objectionable and injurious conditions obtain, and that these are susceptible of much improvement. The operation of wet grinding is carried on generally in basements and cellars, which are damp and dark. In dry grinding, the wheels should be so equipped with hoods and fans as to prevent careless operatives from interfering with these necessary safeguards.

The Stone-cutting and Stone-polishing Industry.

Like the cutlery industry, the operation of cutting and polishing stone indoors is attended by great risk to health. But four establishments of this class were visited, and in all but one there was much dust in the air, and a history of consumption as a leading disease. In this connection, certain facts communicated by the chief medical examiner of one of the largest fraternal benefit organizations are of interest. He states that the statistics of 30,000 deaths show that among the stone cutters there was 1 death from consumption to 2.5 from all other causes, while among carpenters the proportion was 1 to 10.

In this industry, as in the preceding, provisions for the prevention of a dusty atmosphere are called for.

The Tobacco Industry.

As representatives of the tobacco industry, 4 factories, employing from 75 to 900 men and women, were visited. In the operation of making cigars a great deal of dust arises, and in the three largest establishments visited the atmosphere was exceedingly bad from this cause and from overcrowding. In all three the sanitary arrangements were in most unsatisfactory condition. The habit of indiscriminate spitting was general, and it was noticed that many of the cigarmakers completed each cigar with the aid of saliva. The possibility of disseminating loathsome diseases through this practice needs no extended discussion. Perhaps it would be fair to say that it is uncertain how long the germs of certain diseases which might appear to be transmissible in this manner may retain their vitality in contact with moist tobacco, but the idea is sufficiently revolting on æsthetic grounds alone. An objectionable practice, which obtains very generally and which should be the subject of some regulation, is the sale of sweepings. In the operation of making cigars considerable tobacco in larger or smaller pieces falls to the floor. At intervals these are swept up, sifted, and sold as fillings for cheaper cigars. Where the habit of promiscuous spitting prevails, the tobacco thus recovered is likely to be contaminated to some extent with disease organisms which may exist in the secretions of the mouth.

In one smaller factory in the western part of the State the atmosphere was kept pure by means of mechanical ventilating appliances. There was no spitting, and the ends of the cigars were finished with the aid of gum tragacanth rather than with the workmen's saliva.

The Boot and Shoe Industry.

In investigating the boot and shoe industry, 30 different establishments of various sizes, located in 8 different cities and towns, were visited. The number of operatives in these establishments varied between 75 and 3,000. Nearly all of them were provided to some extent with blowers or exhaust fans for mechanical ventilation, but in many instances the apparatus was inadequate for the needs of the establishment. In most of them the sanitary provisions were fair; in some the closets were unexceptional; in some they were unpardonably foul.

In certain processes connected with the manufacture of shoes there is evolution of considerable dust; and this industry, therefore, may fairly be classed among the dusty trades.

A study of the returns of the causes of death from the cities of Lynn and Brockton during three years gives certain results which are in themselves of

some interest as indicating the disease tendency of those engaged in shoe factories, and of still more interest for the purpose of comparison with similar returns from other cities where different industries are followed.

In the city of Brockton, of 167 deaths occurring among shoemakers, 42, or 25 per cent. of the whole, were due to pulmonary consumption; and of this number the proportion of those dying below the age of thirty years was 36 per cent. There were 61 deaths from consumption plus other diseases of the lungs, or 36.5 per cent. of the entire mortality.

In Lynn, during the same three years, of 297 deaths among shoemakers, 65, or 22 per cent., were due to consumption; and 95, or 32 per cent., were due to consumption plus other lung diseases. More than one-half (55.4 per cent.) of those who died from consumption had not yet attained their thirtieth year.

There was one condition which was very noticeable in a large proportion of the shoe factories visited, but by no means peculiar to this line of industry, and that was the habit of indiscriminate spitting. In some instances spittoons were provided, and these appeared to diminish the habit of spitting carelessly upon the floors; in some, spitting is forbidden; in others, it is not forbidden and spittoons are not supplied. In some of the larger establishments everything that can be provided for the health, comfort and happiness of the employees may be found; but in others there is room for very marked improvement.

The Paper Industry.

Nine establishments, engaged chiefly in the manufacture of writing paper and other papers of high quality, were visited. The operatives engaged in certain of the processes of paper making are exposed to considerable dust from rags used in the manufacture; those engaged in other departments are exposed more or less to wet; and those in still others are exposed to no industrial dangers whatever. The most important department of such a mill, from a sanitary standpoint, is the rag-sorting room. In most of the mills visited, provision exists for carrying away, by mechanical ventilation, the dust arising from the handling of the rags; in some, no provision whatever is made. On account of the nature of the raw material, it is generally thought that there is some risk of infection of those who handle the rags, and smallpox is everywhere looked upon as one of the most important possible dangers of the paper industry. It would appear, however, from facts obtainable, that cases of infection traceable to the handling of rags are not common. In some of the establishments, it is said, the rag sorters are seldom sick. In the establishments visited, the operatives had generally the appearance of health and strength. Whether the danger from smallpox is real or imaginary, there is already legislation which is pertinent; for section 138 of chapter 75 of the Revised Laws empowers local boards of health to compel the authorities of any factory to cause all of the workmen to be vaccinated. In certain of the establishments not only is no attention paid to causing the employees to be so protected, but those seeking employment are not asked if they ever have been vaccinated.

In the various paper mills visited, the habit of indiscriminate spitting was observed. The water-closets were, in the main, of the proper sort, and reasonably well looked after; the machinery was found to be well protected. In two rag-sorting rooms the atmosphere was exceedingly dusty, in spite of the presence of twenty-four-inch fans in active operation.

The Textile Industry.

The leading indoor occupation, that is to say, the one in which the largest number of persons is employed in factories in this Commonwealth, is the textile industry in its various branches. The proper investigation of so important an industry would require much more time and a much larger appropriation than were allowed for this entire inquiry.

It is a well-known fact that the dust arising in the various lines of textile work is exceedingly irritating to the respiratory passages, and that tuberculosis finds an enormous number of victims among the operatives. It is, however, a fact, which must not be slighted, that these industries are among the few that are open to persons of weak constitution and poor development. The work in the picking-room, carding-room, spinning-room and weaving-room is not of a kind that appeals to most vigorous men, who can do better, financially and otherwise, in other lines of usefulness.

A few establishments were visited, but our observations were not sufficient to warrant description or advice in regard to this important field of work. That careful study should be given to this industry is indicated by the following results of the study of the mortality due to consumption and other lung diseases among operatives in three mill towns. In one, no less than 36.5 per cent. of the operatives whose deaths were reported died from pulmonary consumption, and 50 per cent. died of consumption and other lung diseases. Nearly 50 per cent. of those who died from consumption were less than thirty years of age at the time of death.

In another, 28.7 per cent. of the decedent operatives died of consumption, and 35 per cent., of consumption plus other lung diseases; and of those dying of consumption, no less than 67.3 per cent. were less than thirty years of age.

In a third, 26.3 per cent. of the deaths among operatives were due to consumption, and 44 per cent., to consumption plus other lung diseases; and of those who died of consumption, no less than 52 per cent. were under thirty years of age.

The Rubber Industry.

In this industry we have to deal both with dust, some of which is both irritating and poisonous, and with noxious fumes. The most important dust is a compound of lead, against the inhalation of which respirators are commonly provided, and almost as commonly refused. Of the vapors which are given off in the various processes, some are nauseous but not directly harmful, and others, as naphtha and carbon disulphide fumes, exert an undoubted injurious influence on the nervous system. In one of the three large establishments visited there was much promiscuous spitting about the floors and into the waste products; in two there was no provision for ventilation except by the windows, although in one of these the room in which the lead compound was mixed with the other ingredients was ventilated by means of a blower. In one mill, which was conducted with proper regard for hygienic conditions, there was a history of cases of chronic lead poisoning; but in the others, one of which was far from sanitary in its general condition, no such evidence could be secured from those in charge.

The Lead Industry.

In the manufacture of white lead, lead pipe and sheet lead, the particular danger is that of chronic lead poisoning, due to the inhalation of dust and to the convey-

ance of lead from the unwashed hands into the digestive system, largely through handling of food materials. Respirators and fan ventilation, and the observance of personal cleanliness, play a great part in reducing this danger. In one of the principal white lead factories, where about 100 men are employed, ventilation by blowers was observed to reduce the dust to a minimum. Respirators are provided, but the workmen will not use them. Occasional cases of lead poisoning are observed, but they can truly be attributed to the negligence of the victims themselves. In the other establishments visited, the hygienic conditions were good, but the employees were in great part careless as to especial danger to their health, incident to this occupation.

Other Industries.

Of the remaining lines of industry investigated, the number of establishments visited and available for examination proved to be so limited in number that deductions drawn from what was observed might not be warranted in the light of further investigation, and hence might be misleading; consequently, it seems best not to attempt to make present use of the facts observed.

Existing Legislation.

Most of the defects to which attention has been called are provided for already in existing laws; but it is to be said that these provisions are more or less scattered, and that in many instances the phraseology is so loose or obscure that they have little or no real value. For example, section 41 of chapter 104 of the Revised Laws, after providing for guarding belting, shafting, gearing and drums, disposes of the important subject of ventilation in the following words, "All factories shall be well ventilated and kept clean," but does not provide any standard by which the adequacy of the ventilation shall be measured. Section 51 of chapter 106 would appear to go somewhat farther, but it requires no extended examination to reveal its defects. It provides as follows: "A factory in which five or more persons and a workshop in which five or more women or young persons are employed shall, while work is carried on therein, be so ventilated that the air shall not become so impure as to be injurious to the health of the persons employed therein, and so that all gases, vapors, dust or other impurities injurious to health, which are generated in the course of the manufacturing process or handicraft carried on therein shall, so far as practicable, be rendered harmless;" but it stipulates nothing as to the processes which shall be followed in rendering these gases, vapors and other injurious impurities harmless, and it fails to establish a limit of permissible impurity, below which the air shall be regarded as possessing no deleterious properties. The next section of the same chapter reads as follows: "If, in a workshop or factory which is within the provisions of the preceding section, any process is carried on by which dust is caused which may be inhaled to an injurious extent by the persons employed therein, and it appears to an inspector of factories and public buildings that such inhalation would be substantially diminished without unreasonable expense by the use of a fan or by other mechanical means, such fan or other mechanical means, if he so directs, shall be provided, maintained and used." In this section there is nothing to indicate who shall be the judge of whether the dust is inhaled to an injurious extent; and, even though it be determined that the dust is so inhaled, there is no provision for mitigating

the condition, unless it shall appear that the danger may be substantially diminished without unreasonable expense.

In its desire to safeguard the health of women and young persons employed in factories and workshops, the Legislature has provided for a proper interval for a midday meal; but a number of different industries are exempt from this requirement, as is shown below. Sections 37 and 38 of chapter 106, Revised Laws, read as follows: "Section 37. No woman or young person shall be employed for more than six hours at one time in a factory or workshop in which five or more such persons are employed without an interval of at least half an hour for a meal; but such person may be so employed for not more than six and one-half hours at one time if such employment ends not later than one o'clock in the afternoon and if he or she is then dismissed from the factory or workshop for the remainder of the day; or for not more than seven and one-half hours at one time if he or she is allowed sufficient opportunity for eating a lunch during the continuance of such employment and if such employment ends not later than two o'clock in the afternoon and he or she is then dismissed from the factory or workshop for the remainder of the day.

"Section 38. The provisions of the two preceding sections shall not apply to iron works, glass works, paper mills, letter press establishments, print works, bleaching works or dyeing works; and the chief of the district police, if it is proved to his satisfaction that in any other class of factories or workshops it is necessary, by reason of the continuous nature of the processes or of special circumstances affecting such class, to exempt it from the provisions of the two preceding sections and that such exemption can be made without injury to the health of the women or young persons affected thereby, may, with the approval of the governor, issue a certificate granting such exemption, public notice whereof shall, without expense to the commonwealth, be given in the manner directed by said chief"

Section 39 of the same chapter practically nullifies the provision, so far as the factories not specially exempted are concerned, since, if the person for whose benefit the provision is made chooses to work during the interval allowed for rest and food, she may do so, if a notice is posted forbidding her to work, and if she does so without the order, consent or knowledge of the employer or his agent, as will be seen: "Section 39. If a minor under the age of eighteen years or a woman shall, without the orders, consent or knowledge of the employer or if a superintendent, overseer or other agent of the employer, labor in a manufacturing or mechanical establishment, factory or workshop, according to the notice required by section twenty-four, and if a copy of such notice was posted in a conspicuous place in the room where such labor was performed with a rule of the establishment, factory or workshop forbidding such minor or woman to labor during such time, then neither the employer nor a superintendent, overseer or other agent of the employer shall be held responsible for such labor." In many of the establishments visited it was observed that those engaged in piece-work gave the shortest possible time to their midday meal, and took no time for rest or for a change of air, but returned as soon as possible to their labor. It is a matter of common knowledge that young persons, especially, suffer injury to health from unbroken confinement indoors and from hasty bolting of food. It would seem as though it might be a wise provision not only to provide that working people shall have a reasonable interval for rest and food, but that they

shall be prevented by something more than posted regulations, which they may violate with impunity, from returning to work until the expiration of the interval.

While the condition of the closets in many of the factories was found not to be up to the standard which seems proper, it must be said that they were no worse than would probably be found in an examination of dwellings and business houses of all sorts. However that may be, the matter is already placed under the supervision and control of the district police by section 8 of chapter 108 of the Revised Laws, which requires the members of the inspection department of the district police to enforce all provisions of the laws relating to sanitary conditions of factories; and section 49 of chapter 106 empowers the inspectors of factories to bring to the notice of local boards of health any unsanitary condition of the water-closets, water supply, or any nuisance; and such boards are required to inquire into the subject and to enforce the laws relative thereto.

Recommendations.

In each of the industries which the Board has reported upon, namely, cutlery grinding, stone cutting and stone polishing, cigar making, boot and shoe making, rag sorting, the rubber industry and the lead industry, one or more establishments were found in which the proprietors had made reasonable provision for protecting the health of the operatives, while in others very little care was taken for their protection. We would recommend that it be the duty of the inspection department of the district police to require, so far as is reasonably practicable under the varying circumstances, as efficient protection to the health of the operatives in any occupation as is provided in that occupation where, within the Commonwealth, such protection is most efficient.

The desirability of a codification of all laws relating to industrial pursuits and to sanitation of factories and workshops after the manner of the British factory acts, of a more explicit phraseology, of the establishment of standards of ventilation efficiency, and of the enactment of some measure against spitting upon the floors of factories, workshops and other confined spaces, is respectfully suggested.

Routine Work of the Board.

Statistical Table for the Year ended Sept. 30, 1904.

Whole number of samples of food and drugs examined during the year,	8,651
Samples of milk examined (included in the foregoing),	4,997
Whole number of samples of food and drugs examined since beginning of work in 1883,	157,356
Whole number of samples of milk examined since beginning of work in 1883,	87,304
Number of prosecutions against offenders during the year,	62
Number of convictions during the year,	57
Amount of fines imposed during the year,	$1,509
Number of packages of antitoxin of 1,500 units each issued to cities and towns,*	22,255
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,*	1,014

* For the six months ended Sept. 30, 1904.

Number of examinations made for diagnosis of tuberculosis,*	494
Number of examinations of blood made for diagnosis of malarial infection,*	24
Number of examinations of blood made for the diagnosis of typhoid fever,*	204
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 75, section 52, Revised Laws,†	26,088
Number of postal-card returns of mortality for cities and towns received and recorded,†	2,111
Number of annual reports of cities and towns received under the provisions of chapter 75, section 12, Revised Laws,†‡	95

Force employed in general work of Board at central office, State House: —	
Secretary,	1
Medical inspector,	1
Clerks,	3
Total,	5

Force employed at central office, State House, Boston, for food and drug inspection, chemists and assistants,	2
At Amherst,	1
Inspectors,	3
Total,	6

Force employed at laboratory (Bussey Institution): —	
Pathologist,	1
Assistants,	6
Total,	7

UNDER THE PROVISIONS OF CHAPTER 375, ACTS OF 1888.

Applications for advice from cities, towns and others: —	
Relating to water supply,	74
Relating to ice supply,	12
Relating to sewerage and drainage,	30
Relating to pollution of streams,	6
Miscellaneous,	3
Total,	125

Number of samples of water, ice and sewage examined chemically and microscopically at the laboratory, Room 502, State House,	4,058
Number of samples of sewage, water and ice examined chemically and bacterially at the Lawrence Experiment Station,	2,179

* For the six months ended Sept. 30, 1904. † For the calendar year 1904.
‡ Cities and towns having a population of more than 5,000 in each.

Number of samples of sand examined chemically at the Lawrence Experiment Station,		278
Number of samples of sand examined mechanically at the Lawrence Experiment Station,		134
Additional samples examined bacterially at the Lawrence Experiment Station,		5,060
Samples of water, ice, etc., examined for B. coli and sewage Streptococcus at the Lawrence Experiment Station,		4,065
Number of shellfish examined for B. coli and sewage Streptococcus,		968
Total number of samples examined,		16,742

Force employed at central office: —		
Chief engineer,	1	
Assistant engineers,	7	
Stenographers and clerks,	3	
Messenger,	1	
	—	12
At laboratory, Room 502, State House: —		
Chemist,	1	
Assistant chemists,	5	
Biologist,	1	
Stenographer,	1	
	—	8
At Lawrence Experiment Station: —		
Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	3	
	—	7
Total ordinary force,		27

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

1886,	8	1897,	59
1887,	22	1898,	75
1888,	28	1899,	79
1889,	38	1900,	104
1890,	23	1901,	105
1891,	53	1902,	93
1892,	56	1903,	129
1893,	51	1904,	125
1894,	53		
1895,	52	Total,	1,218
1896,	65		

Appropriations.

The appropriations for the year 1904, as recommended by the Board in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows: —

For the general expenses of the Board,	$23,000
For the inspection of food and drugs,	12,500
For the production and distribution of antitoxin and vaccine,	8,000
For the purity of inland waters,	34,000
For the examination of sewer outlets and Neponset River,	7,500
For printing the annual report,	4,000
Total,	$89,000

Expenditures.

The expenditures in 1904 under the different appropriations were as follows: —

Appropriation for general expenses of Board,		$23,000 00

General Expenditures, Sept. 30, 1903, to Sept. 30, 1904.

Salaries,	$10,290 01	
Travelling expenses,	662 13	
Stationery,	376 75	
Printing,	2,119 14	
Books, subscriptions and binding,	393 60	
Advertising,	11 65	
Express charges,	282 29	
Extra services,	227 94	
Messenger,	16 20	
Postage and postal orders,	189 64	
Telephone and telegraph messages,	92 52	
Typewriter supplies,	3 75	
Special investigations,	56 55	
Sundry office supplies and incidental expenses,	664 59	
Laboratory supplies,	1,108 91	
Labor,	14 25	
		$16,509 92

Expenditures at Pathological Laboratory at Forest Hills for Three Months (Sept. 30, 1903, to Dec. 31, 1903).

Salaries,	$943 39	
Purchase of animals,	249 20	
Board of horses,	411 85	
Shoeing horses,	1 00	
Food for animals,	44 64	
Amounts carried forward,	$1,650 08	$16,509 92

Amounts brought forward,	$1,650 08	$16,509 92
Apparatus, chemicals and laboratory furnishings and supplies,	2,321 18	
Rental of telephone,	42 00	
Extra services,	10 00	
Travelling expenses,	4 30	
Express charges,	18 07	
Postage,	62	
Printing,	9 51	
Labor,	17 64	
		4,073 40
Total,		$20,583 32

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Nine Months, Jan. 1, 1904, to Sept. 30, 1904.

Appropriation for the calendar year 1904,	$8,000 00
Salaries,	$2,488 34
Purchase of animals,	179 90
Board of horses,	1,223 16
Food for animals,	100 63
Apparatus, chemicals and laboratory supplies,	1,354 24
Ice,	23 71
Stationery,	16 78
Rental of telephone and messages,	80 25
Services of veterinary surgeon,	12 00
Express charges,	129 48
Labor,	152 92
Extra services,	46 00
Printing,	60 87
Total,	$5,868 28

Under the Provisions of the Food and Drug Acts during the Year ended Sept. 30, 1904.

Appropriation,	$12,500 00
Salaries of analysts,	$5,000 00
Salaries of inspectors,	4,280 00
Travelling expenses and purchase of samples,	1,935 13
Apparatus and chemicals,	452 68
Printing,	39 02
Services (cleaning laboratory),	106 00
Express and postage,	10 33
Sundry laboratory supplies,	98 25
Books and maps,	97 30
Extra services (stenographer),	29 15
Typewriting supplies,	21 25
Total,	$12,069 11

Appropriation.

For carrying out the provisions of the act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage,	$34,000 00

Salaries, including wages of laborers at Lawrence Experiment Station,	$25,681 55
Apparatus and materials,	3,110 06
Rent of Lawrence Experiment Station,	150 00
Use of tools and office, Lawrence Experiment Station,	278 10
Travelling expenses,	1,931 37
Express charges,	982 84
Books, book binding, stationery and drawing materials,	496 83
Maps and blue prints,	194 43
Telephone and telegraph messages and postage,	60 22
Typewriter and typewriting supplies,	235 58
Printing,	340 06
Miscellaneous,	526 42
Total,	$33,987 46

The foregoing statement of expenses under the act to protect the purity of inland waters refers to the calendar year 1904.

Appropriation.

For the examination of sewer outlets, under the provisions of section 4 of chapter 75 of the Revised Laws,	$7,500 00

Salaries,	$4,474 60
Apparatus and materials,	1,329 00
Travelling expenses,	1,256 20
Stationery,	1 38
Maps,	11 90
Telephone messages,	3 20
Services, reading gauges and collecting samples,	414 31
Express charges,	1 95
Total,	$7,492 54

HENRY P. WALCOTT.
JAMES W. HULL.
CHARLES H. PORTER.
JULIAN A. MEAD.
HIRAM F. MILLS.
JOHN W. BARTOL.
GERARD C. TOBEY.

Water Supply and Sewerage.

ADVICE TO CITIES AND TOWNS.

ADVICE TO CITIES AND TOWNS.

Under the provisions of the Revised Laws (chapter 75, section 117), the State Board of Health is required to

consult with and advise the authorities of cities and towns and persons having, or about to have, systems of water supply, drainage or sewerage as to the most appropriate source of water supply, and the best method of assuring its purity or as to the best method of disposing of their drainage or sewage with reference to the existing and future needs of other cities, towns or persons which may be affected thereby. It shall also consult with and advise persons engaged or intending to engage in any manufacturing or other business whose drainage or sewage may tend to pollute any inland water as to the best method of preventing such pollution, and it may conduct experiments to determine the best methods of the purification or disposal of drainage or sewage. No person shall be required to bear the expense of such consultation, advice or experiments. Cities, towns and persons shall submit to said board for its advice their proposed system of water supply or of the disposal of drainage or sewage, and all petitions to the general court for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of said board thereon.

During the year 1904 the Board has given its advice to the following cities, towns and persons who have applied for such advice under the provisions of this act or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply and to sources of ice supply, as follows: —

WATER SUPPLY.

Ashfield.
Attleborough.
Attleborough (town farm) (two).
Attleborough (Watson-Newell Company).
Barnstable and Yarmouth.
Barre (Stetson Home).
Boston (spring at Jamaica Park).
Colrain.
Dalton.
Dartmouth (Bay View).
Easthampton.
Easton.
Gloucester (Y. M. C. A.).
Gloucester (Russia Cement Company).
Great Barrington (three).
Greenfield (two).
Hadley.
Hardwick (Gilbertville).
Harvard.
Haverhill.
Holland.

Holyoke.
Holyoke (Holyoke Valve and Hydrant Company).
Holyoke (Whitmore Manufacturing Company).
Hull.
Ipswich.
Lawrence (three).
Lawrence (well at City Hall).
Lawrence (Briggs & Allyn Manufacturing Company).
Lenox.
Lenox (New York, New Haven and Hartford Railroad Company).
Longmeadow.
Maynard (two).
Merrimac.
Millbury (E. G. Howe).
Milton (Houghton school).
Milton (Leopold Morse Home).
Northampton.
North Attleborough (two).
Northborough (almshouse).
Peabody.
Peabody (Frank T. Moore).
Plymouth (two).
Randolph and Holbrook.
Shelburne.
Shrewsbury.
Somerville (M. W. Carr & Co.).
Springfield (four).
Springfield (springs).
Stockbridge.
Uxbridge (three).
Wakefield.
Waltham.
Waltham (Alden Clark).
Wellesley (Wellesley College) (two).
Westford.
Weston (cemetery near source of water supply of Cambridge).
West Springfield.
Woburn (W. W. Cummings).
Worcester.
Wrentham.

ICE SUPPLY.

Chicopee.
Everett.
Falmouth.
Hardwick (Wheelwright).
Holyoke.
Littleton.
Milton.
Nantucket.
Palmer (Three Rivers).
Quincy.
Westport.

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Brockton.
Fairhaven.
Falmouth.
Grafton (Colony for Insane).
Great Barrington.
Haverhill (two).
Holyoke.
Hubbardston.
Lenox (two).
Leominster.
Manchester.
Marblehead.
Northampton (two).
Norwood.
Norwood (Winslow Bros. & Smith Company) (two).
Pittsfield.
Rockland.
Rutland (Industrial Camp for Prisoners).
Salem (two).
Southborough (Deerfoot Farm Company).
South Hadley.
Wakefield.
West Springfield.

Replies were also made in answer to applications for advice relative to the pollution of ponds, streams and other bodies of water, as follows: —

Canton (Neponset Woolen Mills).
Leicester.
New Bedford.
Plymouth.
Quincy.
Swampscott.
Wellesley.
Winchester.
Woburn.
Worcester.
Worcester (Worcester Insane Hospital).

Water Supply.

The following is the substance of the action of the Board during the past year in reply to applications for advice relating to water supply: —

Ashfield.

April 7, 1904.

To the Board of Directors of the Ashfield Water Company.

Gentlemen: — The State Board of Health received from you on March 29, 1904, the following application for the advice and approval of this Board of the taking of Bear Swamp Brook, so called, and its tributaries as a source of public water supply for the town of Ashfield: —

> The Ashfield Water Company hereby makes application to the State Board of Health for its approval of Bear Swamp Brook in the town of Ashfield as a source of water supply for the inhabitants of said town.
>
> The Ashfield Water Company proposes to take the waters of Bear Swamp Brook, as authorized by chapter 77, Acts of 1904; to construct a reservoir on said brook of about 40,000 gallons' capacity, at an elevation of 335 feet above the village; to conduct the water through about 2,000 feet of 4-inch pipe to a service reservoir of 200,000 gallons' capacity, at an elevation of about 215 feet. From the service reservoir the water is to be conducted through 7,000 feet of 8-inch pipe to the village street, where it is to be distributed through 6-inch and 4-inch mains.

The Board has considered the results of recent examinations of the proposed source of supply and of analyses of the water, and has examined the plan submitted by you.

The point at which it is proposed to take water from the brook, as indicated in your plan, is just above the highway crossing, about one-fifth of a mile above the point where the brook crosses the main road leading from Ashfield to Hawley. Examinations made by the Board show that at the present time the drainage area of the brook above this point is free from dwelling houses or other possible sources of pollution, and that the water is of good quality for all the purposes of a public water supply.

The Board has no definite information showing the flow of Bear Swamp Brook in very dry weather, but is informed that the flow is well maintained; and it is probable that a sufficient supply of water will be secured from the reservoir which it is proposed to construct, taken in connection with the

service reservoir referred to in your application, which it is understood will be supplied wholly from the Bear Swamp Brook, and not from another water-shed. If there should be a shortage of water at any time, it will be practicable to build a storage reservoir upon Bear Swamp Brook just above the intake reservoir now proposed there, and in this way secure an adequate supply.

The Board hereby approves the taking of Bear Swamp Brook at the point indicated above as a source of water supply for the town of Ashfield, under the provisions of chapter 77 of the Acts of the year 1904.

ATTLEBOROUGH.

OCT. 6, 1904.

To the Board of Water Commissioners of the Town of Attleborough, Mr. GEORGE H. SNELL, *Superintendent.*

GENTLEMEN: — The State Board of Health received from you on August 17 the following application for advice relative to a proposed additional water supply for the town of Attleborough: —

I hereby request your approval of certain improvements in the development of the present water supply. The present well does not permit of water being drawn from the ground at a rate such that the present pumping plant can be economically operated.

It is therefore proposed to construct another well on the opposite side of Seven Mile River, and connect this new well with the present well by a masonry conduit laid at the elevation of bottom of well, this conduit to be of dry masonry, so as to serve as additional means of interception.

Test wells have been sunk, and good material has been found.

We submit with this application a blue print showing the proposed new work, also the location of the test wells.

The application was accompanied by a blue print showing the location of the proposed new well, and of test wells sunk in the neighborhood of the present and proposed wells to determine the character of the soil.

The plans provide for supplementing the present supply, which is drawn from a well 30 feet in diameter and 25 feet deep, located about 150 feet south-east of the Seven Mile River, a short distance above its entrance to Orr's Pond, by constructing a new well on the opposite side of the river, about 50 feet from the stream and 210 feet from the present well. The proposed new well is to be 40 feet in diameter, and to be sunk about 1 foot lower than the bottom of the present well.

The Board has considered the proposed plans, and has caused the locality to be examined by one of its engineers and samples of the water of the test wells to be analyzed.

The quality of the water of the present source of supply is excellent, but experience has shown that the yield of the well is hardly sufficient for the supply of the town under present conditions, and in a very dry season

the quantity obtainable from this source would probably be inadequate. Analyses of samples of water from the test wells located in the neighborhood of the proposed new well show that the water does not differ materially in quality from that of the present source of supply, and the indications are that water of good quality would be obtained from the proposed well.

The test wells were sunk in porous soil, and water could be pumped from them very freely. Observations upon the height of water in these wells indicate that the ground water in this locality is already influenced by pumping from the present well; but by constructing the proposed well a much larger portion of the water stored in the ground in this region would be made available, and the area from which the water would filter toward the sources of supply be enlarged, so that a considerable increase in the yield of your sources of supply would be secured by the construction of the proposed works. It is very important to secure an additional supply without delay; and under the circumstances, in the opinion of the Board, the proposed well and conduit are a desirable addition to your sources of supply.

It is evident that much water from the Seven Mile River enters the ground in the region through which the proposed conduit will pass; and it is important, in laying this conduit, to exclude ground water from beneath the river bottom, or at any place where imperfectly purified water is liable to enter this channel.

Attleborough (Town Farm).

June 2, 1904.

To the Board of Overseers of the Poor of the Town of Attleborough.

Gentlemen: — The State Board of Health has considered your application for advice with reference to the quality of the water of a well recently put in at the town farm, and has caused the well and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water is grossly polluted, apparently by drainage and foul matter from an adjacent barn cellar, and is unfit for drinking. The Board would advise that this well be closed, and the possible use of its water for drinking or cooking be prevented.

Dec. 1, 1904.

To the Board of Overseers of the Poor of Attleborough, Mr. Benj. W. King, *Chairman.*

Gentlemen: — In response to your request, the State Board of Health has again caused the well at the Attleborough town farm to be examined and a sample of the water to be analyzed. The results of the analysis show some improvement as compared with the first examination of the water of this well, but the water is still very badly polluted, and in the opinion of the Board is unfit for drinking.

ATTLEBOROUGH (WATSON-NEWELL COMPANY).

AUG. 4, 1904.

To the Watson-Newell Company, Attleborough, Mass.

GENTLEMEN: — The State Board of Health has caused an examination to be made of the water of driven wells located near your factory, which it appears have been put in with a view to furnishing a supply of water for manufacturing purposes and also for drinking in the factory, and has caused a sample of water from one of the wells to be analyzed. This well, which the Board is informed is 38 feet deep, is located about 300 feet from the factory in low land near the Ten Mile River.

The results of the analysis show that the water contains an excessive quantity of iron, which would make it objectionable for drinking and some other uses. The presence of this iron is probably caused by the imperfect filtration of water passing through the ground from the Ten Mile River, a stream which receives much pollution from villages above this point, and under the circumstances the Board does not advise the use of this water for drinking.

BARNSTABLE AND YARMOUTH.

JUNE 2, 1904.

To the Barnstable Water Company, Mr. EBEN A. THACHER, *Temporary President, 159 Devonshire Street, Boston.*

GENTLEMEN: — The State Board of Health received from you on May 10, 1904, an application for the approval of a proposed source of water supply for the towns of Barnstable and Yarmouth, in which your proposed scheme is described as follows: —

By the proposed system the supply of water will be obtained from driven wells located near the southerly end of Wequaquet Lake.

The location of the wells, the details of their construction, and the land which it is proposed to purchase, are shown on the accompanying plans: 1. Plan showing location of proposed driven well system, Barnstable water works, dated May 9, 1904, Peirce & Barnes Company, engineers; 2. Barnstable water works, plan of driven well system, December, 1903, Alfred O. Doane, consulting engineer, and Peirce & Barnes Company, engineers.

The system herein proposed is intended to be in accordance with the general recommendation of your Honorable Board, made last year in reply to an application for advice and approval of a plan to take water from Wequaquet Lake.

It is believed that the system now proposed will not interfere in any way with the use of Wequaquet Lake and its shores for boating, fishing, hunting and other purposes for which the lake and its shores are now used.

In advising the Barnstable Water Company upon the proposed system of water supply, your Honorable Board is requested to inform the company whether said system will in any way interfere with the uses to which the lake and its shores are now put. It is of considerable importance to the company to be informed on this point, as the company desires to take its supply from such places and in such a manner that there will be no interference with the present uses of the lake and its shores.

The application is accompanied by plans showing the location of the proposed tubular wells, as described in the foregoing statement.

In response to this application, the Board has caused the locality to be examined by one of its engineers and samples of water from two of the test wells to be analyzed.

The results of the analyses show that the water of these wells is soft, and otherwise of good quality for the purposes of a public water supply.

The results of tests made by pumping water from test wells in this locality show that water can be obtained freely from the ground by means of suitable collecting works, and, taken in connection with observations upon the height of the ground water, indicate that a sufficient quantity of water for the supply of the towns of Barnstable and Yarmouth can be obtained from the ground in this region; and the Board approves the use of ground water from the locality for the supply of the towns of Barnstable and Yarmouth.

In the opinion of the Board, the use of water from the ground in the locality indicated, provided that all collecting works are located 100 feet or more from the shores of the pond, and an adequate area is secured about the wells to prevent danger of pollution of the ground water in this neighborhood, need not interfere with boating, fishing or hunting upon Wequaquet Lake, or other proper and legitimate use of that lake or its shores.

Barre (Stetson Home).

Sept. 1, 1904.

To Mr. J. N. Barss, *Superintendent Stetson Home, Barre, Mass.*

Dear Sir: — In response to your request of August 4 for an examination of the water supply used at the Stetson Home, and advice as to its quality, the Board has caused the sources of supply to be examined by one of its engineers and has caused samples of the water to be analyzed.

It appears that the water supply is at present drawn from three wells: one a dug well, 30 feet deep, located about 50 feet south-east of the road to Barre; the second a 3-inch tubular well, 150 feet deep, located 20 feet south-east of the first well; and the third a well 25 feet deep, dug in the cellar of a dwelling house, the latter well being within about 20 feet of a privy vault. Water from the first two wells is pumped to a tank, whence it flows to a tank in the school building and is supplied for use there, the water of the third well being used only for the supply of the dwelling house.

The results of an analysis of the water of the well in the dwelling house shows that it has been considerably polluted; and, while at the time this sample was collected the water was being very thoroughly purified before entering the well, and was probably at that time safe for drinking, its quality is liable at any time to deteriorate, and it is advisable, in the opinion of the Board, to discontinue the use of this source.

Analyses of the water of the other two wells from which the supply used in the school is drawn show some evidence of previous pollution; but at the present time the possible sources of pollution are remote, and the Board is of the opinion that the water of these sources might safely be used for drinking. The water of the deep tubular well, however, contains such an excessive quantity of iron that it is objectionable for drinking and many other purposes. It would be practicable to remove the excessive quantity of iron by means of a properly constructed filter; but the expense of constructing and maintaining such a filter would probably be greater than the cost of obtaining a new supply by sinking a well in a locality where the water is not affected by the presence of an excessive quantity of iron.

Boston (Jamaica Park).

July 7, 1904.

To the Board of Commissioners of the Department of Parks, Jamaica Plain, Mr. George F. Clarke, *Secretary.*

Gentlemen: — In response to your request of June 3 for an examination of the water supplied from the city mains at Jamaica Park, and also of the water of a spring in the park near the corner of Chestnut and Perkins streets, the Board has caused the locality to be examined and samples of the waters indicated to be analyzed.

The water from the city mains, you state, is so full of sediment at times as to be undrinkable, usually being worse in the morning than at other times. This is doubtless due to the fact that the faucet from which the water is drawn is located at the end of a long section of pipe from which there are no other takers. It is probable that, by providing a proper means of flushing this pipe, and by flushing it in the morning before water is drawn for drinking, the water would be of satisfactory quality.

The water of the spring near the corner of Chestnut and Perkins streets is of good quality for drinking. The spring is exposed to possible pollution by fertilizers or other matters deposited upon the slope above the spring, which might be carried into the spring at times of rain. If provision should be made to prevent matters deposited here from being washed into the spring, and if the spring should be covered so that it would not be polluted by persons dipping up water, this spring would be a safe source from which to take water for drinking.

Colrain.

July 21, 1904.

To Messrs. W. S. Allard, Charles A. Macey and Charles J. Russell, *Commissioners of the Colrain Fire District No. 1.*

Gentlemen: — The State Board of Health has considered your request of June 27 for the advice and approval by this Board of the taking for domestic purposes, under the provisions of chapter 318 of the Acts of the

year 1902, of the waters of Mountain Brook, so called, in the town of Colrain, and has caused the proposed source of supply to be examined by its engineer and a sample of the water to be analyzed.

The water, as indicated by the analysis of a sample collected recently at the reservoir already constructed by the district, though somewhat hard, is in other respects of good quality for the purposes of a public water supply; and an examination of the water-shed shows that this area is practically uninhabited above the point where your reservoir is located, the only dwelling house in the neighborhood being so close to the limit of the water-shed that it is unlikely that polluting matters from this place can affect your source of supply.

The water of the reservoir is unfavorably affected at times by street wash from a road which passes near the head of the reservoir. The street wash could be conveyed in the gutter on the opposite side of the street from the reservoir to a point of discharge into the brook below the reservoir without special difficulty, and this change should be made before the water is used for domestic purposes.

While the quantity of water which this source will yield in dry weather is evidently small, it is likely to be sufficient for the requirements of the village; and the Board hereby approves the taking of Mountain Brook at the reservoir now located on that stream as a source of water supply for domestic purposes for the village of Colrain.

DALTON.

Nov. 3, 1904.

To the Board of Water Commissioners of the Dalton Fire District.

GENTLEMEN: — In accordance with your request, the Board has caused an examination to be made of Anthony and Beall's brooks, with a view to their use as sources of water supply for Dalton, and has caused samples of their waters to be analyzed.

The water-shed of Anthony Brook, which is contiguous to that of your present source — Egypt Brook — on the west, is uninhabited, and the waters of the two branches, while somewhat colored with vegetable matter, are of good quality for drinking.

The water-shed of Beall's Brook contains one dwelling house, unoccupied, however, at present, and two buildings which are said to be occupied during the winter. The analyses of the water show that it is naturally of good quality for water-supply purposes, and if suitable provision is made for preventing pollution of the stream from buildings on the water-shed, this stream may safely be used as a source of water supply for Dalton.

Regarding the quantity of water which these sources are likely to yield in the drier part of the year, it is not practicable to make a definite estimate, but with the aid of the storage in your reservoirs the use of these

streams is likely to add considerably to the quantity of water available for the supply of the district; and the cost of works for obtaining water from these sources is not likely to be very large in the case of Anthony Brook, while in the case of Beall's Brook a pipe line of sufficient size can be laid so that it may be extended, when necessary, to May Brook farther east.

In the opinion of the Board, Anthony and Beall's brooks are appropriate sources of additional water supply for Dalton.

Dartmouth (Bay View).

Sept. 1, 1904.

To Mr. Charles W. Howland, *Chairman Board of Health, Dartmouth, Mass.*

Dear Sir: — In response to your request for an examination of the water of a well used as a source of water supply for the summer settlement of Bay View, and advice as to its quality, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

This source was examined by the Board in 1899, and at that time the owner was advised that the water showed evidence of having been at some time polluted but subsequently well purified in its passage through the ground before entering the well, and that the water, under the conditions existing at that time, was suitable for drinking and other domestic uses. Since the time of the previous examination a tubular well has been driven in the bottom of the large well to a depth of about 100 feet.

Upon comparing the results of the recent analysis with the results of the previous test, it is found that the water has deteriorated slightly in some respects, but the indications are that it was safe for drinking at the time the recent examination was made.

There are cesspools and other places where sewage is deposited in the ground not far from the well, and the danger in the use of such a source is that some change in the conditions affecting the pollution of the water may at any time cause it to deteriorate in quality and become unsafe for drinking; and the Board would advise that while this source is continued in use its condition be examined carefully from time to time, and its use discontinued if deterioration occurs. It is desirable that a water supply from some unpolluted source be obtained for this village, and the further use of the present source discontinued.

Easthampton.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on July 7, 1904, for preventing the pollution and securing the sanitary protection of the waters of Bassett Brook and its tributaries, used by the town of Easthampton as a source of water supply.

EASTON.

OCT. 6, 1904.

To Mr. WILLIAM H. AMES, *Water Commissioner, North Easton Village District, North Easton, Mass.*

DEAR SIR: — In accordance with your application of August 4 for an examination of the water of two deep tubular wells located on either side of your present well, the Board has caused the locality to be examined and samples of the water of the wells to be analyzed.

The results of the analyses indicate that the water of well No. 1 is of good quality for the purposes of a public water supply, the quality differing but little from that of your present well. The water of well No. 2 is not satisfactory.

Well No. 1 is distant about 75 feet from the present well, and, while it was sunk to a much greater depth than the present well, it was bored largely in rock, and it is unlikely that the yield of your sources of supply will be materially increased by the use of this well.

The consumption of water in the North Easton village district is increasing rapidly, and it is unlikely that the yield of the sources of supply, including the new well, would be sufficient for the requirements of the village in the drier portion of a dry season.

The reservoir located near the well is supplied with water from the Queset River, a stream which receives considerable pollution; and the water of this reservoir should not be used for the supply of the town unless filtered in a proper manner before being introduced into the water-supply system.

It appears that there is a system of pipes laid beneath the bottom of this reservoir, with a view to collecting ground water. The Board is informed that water from this source has not been used, and no knowledge is available as to its quality. Judging from experience with similar systems for collecting water in other places, the quality of the water obtainable from these pipes would be likely to be objectionable for many domestic uses, and imperfectly filtered water from the reservoir might find its way into them.

In the opinion of the Board, it is advisable for the district to cause an investigation to be made, with a view to obtaining an additional source of water supply which may be available for use when necessary. There appear to be opportunities for securing an additional supply of water from the ground at several places at no great distance from your present well, and it may also be practicable to filter water from the Queset River through the gravelly land bordering the stream, and secure water of good quality and in sufficient quantity for the additional requirements of the village.

Should you decide to make further investigations, the Board will, upon

application, give you such assistance as it can in the matter by making the necessary analyses of samples of water, and will give you further advice when the results of further investigations are available.

Gloucester (Y. M. C. A.).

June 2, 1904.

To Mr. Reuben Brooks, *Chairman, Building Committee of Y. M. C. A., Gloucester, Mass.*

Dear Sir: — In response to your request of May 9 for advice as to the quality of the water of a well which it is proposed to use as a source of water supply for the Y. M. C. A. building in Gloucester, the Board has caused the well and its surroundings to be examined and a sample of the water sent in by you to be analyzed.

The results of the analysis show that the water of this well is grossly polluted by sewage, and is also probably affected by sea water, and the Board would advise that the possibility of its use for drinking or cooking be prevented.

Gloucester (Russia Cement Company).

Sept. 1, 1904.

To Mr. Reuben Brooks, *President Russia Cement Company, Gloucester, Mass.*

Dear Sir: — In response to your request of July 30, the Board has caused certain wells at your factory, which you propose to use as a source of drinking water supply for the operatives, to be examined and a sample of the water to be analyzed.

The wells indicated are located in the bottom of a pond near the factory, and the Board is informed that they have been driven to a depth of about 25 feet beneath the bottom of the pond.

The pond is a small artificial reservoir, the water of which is exposed to pollution from several buildings on its water-shed. The water of the wells gives evidence of considerable pollution, and the water of wells located in the bottom of a pond, as these are, is likely to deteriorate after a considerable quantity of water has been drawn. The water does not appear to be unsafe for drinking at present, but, since its quality is liable to deteriorate, the Board would advise that it be examined from time to time, and its use discontinued if deterioration occurs.

Great Barrington.

March 3, 1904.

To the Water Committee, Great Barrington, Mass., Mr. George D. Goodrich, *Chairman.*

Gentlemen: — The State Board of Health has considered your application for advice as to the taking of Seekonk or Alford Brook as a source of water supply for Great Barrington, and has caused the source to be examined by one of its engineers.

It appears from oral statements by members of your committee that two plans are under consideration, though no definite information concerning either of them has been submitted to the Board.

One plan provides for taking water from the brook at a point near its mouth, using the water of Green River to furnish power for pumping, and all of the water supplied from this source would have to be pumped by this plan. The examinations made by the Board show that the water of the brook at this point is not only objectionable on account of hardness, but that it will probably be impracticable to adequately protect it from pollution; and, in the opinion of the Board, Seekonk Brook at this point is neither a desirable nor a safe source of water supply.

By the second plan the Board is informed that a small dam would be constructed across the brook, about five miles above its mouth and about a mile and a half above the village of Alford. By this plan water could apparently be supplied to the town by gravity under a somewhat greater pressure than is furnished by the present low-service system, but the source would not be high enough to supply the high-service system.

The water of the brook at this point also is objectionably hard, and, as there is a considerable population in buildings located close to the brook and its tributaries above this point, and much of the land is highly cultivated, the protection of the source from pollution would be difficult and expensive. In the opinion of the Board, this brook is not a desirable source of water supply for the fire district.

Other sources offering greater advantages both in respect to the quality of the water and the economy of constructing works appear to be available, but adequate investigation of these sources has not yet been made to determine the quantity or quality of water that they can be depended upon to yield by any practicable plan of development.

NOV. 3, 1904.

To the Committee on Water Supply of the Great Barrington Fire District, Mr. A. C. COLLINS, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Oct. 4, 1904, an application, under the provisions of section 117, chapter 75 of the Revised Laws, requesting the advice of the Board as to a proposed water supply for Great Barrington, in which you state: —

The advice of the Board is desired on the adoption of the source of supply described and recommended by Mr. Percy M. Blake, viz., the Goodale Brook in the town of Mt. Washington, in his report, a copy of which has been forwarded to you. Or, if such source does not receive the approval of your Board, it is desired that you recommend such other source, of those described by Mr. Blake, as may be best adapted to the needs of the district.

The application is accompanied by a report of your engineer, Mr. Percy M. Blake, in which various possible sources of water supply are considered, with the final recommendation that water be introduced from Goodale Brook and a portion of the water-shed of Wright Brook, supplemented when necessary with water from Fenton Brook.

The plan provides for the construction of two storage reservoirs on Goodale Brook, each to hold about 24,000,000 gallons; and a canal is indicated, running from the southerly end of the water-shed of Goodale Brook across a portion of the water-shed of Wright Brook, by which it is proposed to intercept some of the flow of the latter water-shed and divert it into Goodale Brook. At Fenton Brook it is proposed to construct a reservoir holding about 1,500,000 gallons of water at about the same elevation as the lower reservoir on Goodale Brook, and to construct a branch pipe line from this reservoir to the main pipe from Goodale Brook to the village.

Several other possible sources of supply have been considered by your engineer, and estimates of the cost of works for obtaining water from these sources are submitted.

The Board has caused the various sources available for the water supply of Great Barrington to be examined by its engineer, and has considered the information that has been collected and submitted concerning them and the results of the analyses of the various waters. Of the various sources considered, Goodale Brook, Prospect Lake and Harmon Brook have decided advantages both in the matter of economy and in other respects over any of the others that have been mentioned as possible sources of water supply for Great Barrington. The water of Goodale Brook as it flows in the stream is softer than that of either Prospect Lake or Harmon Brook, and is nearly free from color. The water of Prospect Lake is also nearly colorless, while the water of Harmon Brook is somewhat colored. It is probable that the water of Prospect Lake is affected at times by growths of organisms which impart to the water a disagreeable taste and odor, and the waters of Goodale Brook or Harmon Brook would probably be affected in a similar way by storage in the reservoirs which it would be necessary to construct in order to obtain a sufficient supply from these brooks. The principal advantage in quality that either of the sources would possess over the others after development as proposed would be that the water of Goodale Brook would probably be somewhat softer than that of Prospect Lake or Harmon Brook.

The water-sheds of all three sources contain dwelling houses and farm buildings, and it would be necessary in each case to make provision for the prevention of the pollution of the source from such places.

Harmon Brook, developed as proposed by your engineer, would yield an ample quantity of water for the present and future requirements of Great Barrington, so far as they can now be foreseen, and the source is capable of further development. Prospect Lake would probably yield at present enough water for the requirements of the district in the driest of seasons; and the investigations have shown that it is practicable to increase the yield of the lake by raising its level and diverting into it the waters of adjacent water-sheds, so that it will be capable of furnishing an ample supply for the present and future requirements of the district. By constructing both

the reservoirs suggested on Goodale Brook, holding together 48,000,000 gallons, a somewhat greater quantity of water than the estimated amount now used by the district could be obtained from this source; and by using in connection therewith the portion of the Wright Brook and Fenton Brook water-sheds that can be made available, enough water can be obtained from this source to supply a population much larger than that now living in the district, unless the use of water should be excessive. There appears to be no practicable plan of developing this source further than is indicated in the plans submitted, and it is doubtful whether it can be depended upon in a very dry year to yield more than about 750,000 gallons per day.

The estimates of cost submitted indicate very clearly that, if all items of cost and damage be included, the cost to the district of taking a supply of water from Prospect Lake would be considerably less than the cost of an adequate water supply from Goodale Brook or from Harmon Brook.

Considering all the circumstances, the Board is of the opinion that the most appropriate source of water supply for the district is Prospect Lake and the water-sheds contiguous thereto. Goodale Brook, however, developed and supplemented as proposed, would furnish a sufficient quantity of good water to supply the needs of the district for several years, and possibly for many years if the growth should be slow and the use of water moderate. Aside from the greater cost of the works, there is no objection to the taking of a supply of water from Goodale Brook, supplemented with water from Wright and Fenton brooks.

JAN. 5, 1905.

To the Committee on Water Supply of the Great Barrington Fire District, MR. A. C. COLLINS, *Chairman*.

GENTLEMEN: — The State Board of Health received from you on Nov. 22, 1904, a communication requesting further advice relative to the proposed sources of water supply for the Great Barrington Fire District, as follows: —

Your communication of November 3, relative to a proposed water supply for Great Barrington, was duly received and contents noted.

We appreciate your suggestions in regard to Prospect Lake as a more economical supply and possibly a larger supply than Goodale Brook, which is recommended by Mr. Blake in his report. Our committee, however, have much hesitation about recommending Prospect Lake to the fire district, on account of the quality of the water. Of course we appreciate the fact that the quality would be improved by raising the dam and increasing the depth of water; but so much is said about the strong odors from the lake during the hot weather, that we very much doubt if this objection can be entirely overcome. We dislike to take any chances on the quality of the water that we are to get, especially during the summer months, when many people from the cities are likely to be here, and when we should be especially criticised for any disagreeable odors or color in the water.

Would there, in your opinion, be any difficulty in removing the color to the water of Harmon Brook, as suggested in Mr. Blake's report? This source of

supply would be undoubtedly an adequate one, but is subject to some criticism on account of the color.

The city of Springfield has had so much trouble with the quality of its water supply that we do not want to take any chances in that respect. While there is not the abundance of water in Goodale Brook that we could wish, yet its quality is so excellent that we feel very friendly to Mr. Blake's report in favor of that supply, as he seems to regard it as adequate.

None of our committee has any special prejudice in favor of either supply. We simply want to solve the problem, if possible, for the best interests of the fire district, and to correctly settle the long-vexed problem.

Dr. Lane, who is a member of our board of health, feels very strongly that the water of Prospect Lake would not be satisfactory during the summer months unless a large amount were expended in cleaning the lake. I enclose herewith a copy of a communication which I have just received from him on this subject.

If I understand your letter correctly, you are prepared to approve either Goodale Brook or Harmon Brook, in case the district should adopt either of these sources in preference to Prospect Lake. Is this correct?

The information available to the Board as to the character of the water of Prospect Lake is that which is furnished by the results of analyses of samples of this water collected in August, 1899, and in the months of July and October, 1904; and the results of examinations of the lake and its surroundings by its engineer, and the information furnished by the investigations of your engineer, Mr. Blake. The water collected from the lake in August, 1899, had a vegetable odor when examined by the severe tests of the laboratory, but the other samples were odorless. A very faint odor was developed in two samples upon heating the water. The quantity of organic matter present in the water, as indicated by the albuminoid ammonia in these samples, was no greater than is found in good pond or reservoir waters in the warmer portion of the year, and the water had but little color.

Nearly all surface waters, when stored in ponds or reservoirs, are affected at times by growths of organisms which impart to the water a disagreeable taste and odor, and it is not unlikely that the water of Prospect Lake would be affected at times in this way, as you have already been advised; but, so far as the analyses show, this water is not likely to be seriously affected by tastes or odors in the summer season.

Examinations of the lake and its surroundings show that the conditions are naturally favorable for the storage of water; and if the lake should be drawn down, the bottom cleaned and the organic matter removed from the areas which would be flowed by reason of raising its level, the danger that the water would be objectionable on account of disagreeable tastes and odors would be diminished. These improvements could apparently be made without serious difficulty.

If either Goodale Brook or Harmon Brook should be used as a source of water supply by the district, it would be necessary, in order to secure a

sufficient supply, to construct reservoirs upon them and use the reservoir waters in the drier portion of the year. The waters of these reservoirs would be liable to be affected in a manner similar to that of Prospect Lake, and it is not practicable to tell beforehand whether they would be affected in a greater or less degree than the lake water.

If the water of Harmon Brook should be filtered in a proper manner, it is probable that the color would be somewhat reduced; but experience with the operation of water filters covering a period of more than ten years shows that the greatest reduction of color by filtration is unlikely to exceed about 30 per cent., and that in some years the reduction would not be much over half as great, and the color of the water of Harmon Brook after filtration would probably be somewhat greater than that of Prospect Lake.

The only practicable plan of insuring a water free from taste or odor from either of the sources will be to filter the water; and works constructed for supplying water to the district from either of the three sources could be so designed in the beginning as to allow for the subsequent introduction of filters, if, after experience, it should be found that the quality of the water was objectionable on account of taste or odor, and that filtration was desirable. The condition of Prospect Lake is not at all comparable with that of the water supply of Springfield, the water of the latter city being taken from a very large reservoir formed by flooding an area containing an extensive swamp, without removing stumps, muck and other organic matter.

The Board is prepared to approve either Goodale Brook or Harmon Brook, developed as proposed in the plan most recently submitted, in case the fire district should adopt either of these sources in preference to Prospect Lake.

GREENFIELD.

JULY 7, 1904.

To Messrs. C. J. DAY, E. A. NEWCOMB and CHARLES R. LOWELL, *Water Commissioners and Prudential Committee, Greenfield Fire District.*

GENTLEMEN: — The State Board of Health has considered your application of June 16 for advice as to the preparation of the bottom of the proposed new storage reservoir for the water supply of the Greenfield Fire District now under construction upon Glen Brook, a short distance above your present reservoir, and has caused the locality to be examined by its engineer.

It appears that the new reservoir will be formed by a dam about 40 feet in height, which will flood an area of about 7.1 acres to an average depth of about 17 feet. The storage capacity of the proposed new reservoir will be about 40,000,000 gallons, and the total storage capacity of this and the present reservoir, taken together, will be about 64,000,000 gallons.

The water of Glen Brook is clear and nearly colorless, and contains

naturally but little organic matter. Experience with such waters has shown that they deteriorate when stored in reservoirs, and are affected at times by the presence of minute vegetable organisms in suspension in the water which often impart to it a disagreeable taste and odor. Trouble from this cause has been slight with the water of your present reservoir, probably, in part at least, on account of the fact that the capacity of the reservoir is small in proportion to the size of the water-shed, so that the water changes rapidly at all seasons of the year.

The water stored in the proposed new reservoir will change less rapidly, and there will be a greater opportunity for the development of organic growths which cause disagreeable tastes and odors in water than in the case of the present reservoir, since the water will be stored for a longer time.

Experience shows that such organic growths develop less extensively in reservoirs which have been carefully prepared for the storage of water by the removal of all of the soil and organic matter from the area flowed than in those which have received less thorough preparation; and it is desirable to diminish the possibility of serious trouble from this cause by removing materials liable to promote organic growths.

The area to be flowed consists of the steep and rocky sides of a narrow glen, originally covered with a heavy growth of wood, which has been cut down and is being removed. The soil of this area consists chiefly of hard-pan and rock, overlaid in places by a thin layer of loam or vegetable mold, composed in part of decayed leaves, sticks, etc. The Board would advise that all stumps and vegetable matter be removed from this area, including also such soil as may contain roots or grasses, so that the surface exposed to the water may be free from such organic matters.

In the work of constructing the dam and preparing this reservoir, which has already been begun, it will be necessary to introduce a considerable number of laborers into the water-shed above the reservoir from which your present supply is drawn; and, in order to protect the purity of your present source of supply while this work is in progress, it will be necessary for you to provide means for the sanitary protection of your water supply, and to exercise such supervision of those employed on the work as will insure the protection of the water supply from pollution. The Board regards this matter of the greatest importance, since serious epidemics have resulted from the introduction of laborers into a water-shed used as a source of public water supply, under such circumstances as these.

It also appears, from an examination of the water-shed of Glen Brook above your present reservoir, that the water is exposed to considerable danger of pollution from several groups of farm buildings, some of which are near the streams feeding the reservoir. By the enforcement of suitable sanitary rules and regulations it will be possible to protect your sources of supply from pollution from most of these places. Some of

these places are so situated with respect to the streams that it will be difficult to protect your sources of supply efficiently from pollution from these places; and, in order to secure adequate protection, it will be necessary for the town to secure control of some of the lands within this water-shed. It is especially important that a sufficient area should be controlled about your reservoirs to protect them from possible pollution. The Board will, if you so request, provide rules for the sanitary protection of your water supply, as authorized by chapter 75 of the Revised Laws of Massachusetts.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on Aug. 4, 1904, for preventing the pollution and securing the sanitary protection of the waters of Glen Brook Reservoir and its tributaries, used by Fire District No. 1 in the town of Greenfield as a source of water supply.

HADLEY.

OCT. 6, 1904.

To Messrs. F. H. SMITH and E. S. ALLEN, *Water Supply Committee of the Town of Hadley.*

GENTLEMEN: — The State Board of Health, in accordance with your application of Aug. 23, 1904, for advice as to obtaining a water supply for the village of Hadley from the streams known as Sheep Pasture Brook, Middle or Stony Hill Brook, and Shingle Mill Brook, in Hadley, has caused these sources to be examined by one of its engineers and samples of their waters to be analyzed.

The results of the analyses show that the waters of these sources were at this time clear and nearly colorless and contained little organic matter, and were in other respects of good quality for the purposes of a public water supply. It is unlikely that the quality is very different at other seasons of the year. The water-sheds are at the present time uninhabited, and the waters can be protected from pollution in the future without difficulty.

Regarding the quantity of water which these sources can be depended upon to furnish, very little information is available, though weir measurements made during the past summer indicate that the flow is well maintained in ordinary years. It is very doubtful, however, whether the flow of the three sources taken together would be sufficient for the supply of the town unless provision should be made for storing water in a reservoir for use in the drier portion of the year. An examination of the water-sheds of the brooks shows that upon one of them there is a favorable site for a storage reservoir which would apparently hold from 3,000,000 to 4,000,000 gallons; and if further investigations shall show that it is practicable to construct a storage reservoir of the size indicated on either of the streams and to divert the waters of the other streams into the reservoir, it is prob-

able, in the opinion of the Board, that an adequate supply of water for the village of Hadley could be obtained from the three streams indicated, and at less expense than in any other way. If this plan should be adopted, and an additional supply should become necessary, it could probably be obtained from other water-sheds in this neighborhood.

Hardwick (Gilbertville).

April 7, 1904.

To the Board of Health of Hardwick, Mr. Charles F. Angell, *Agent.*

Gentlemen: — In response to your communication received March 26, 1904, requesting an examination of the water supplied to the village of Gilbertville with reference to its action upon lead pipes, through which the water is supplied, the Board has caused the sources to be examined and samples of their waters to be analyzed.

It appears from this examination that the water supply of the village, which is drawn from springs on neighboring hillsides, is supplied exclusively through lead pipes, the length of lead pipe between the source of supply and the consumers being in some cases nearly half a mile.

The results of the analyses of samples of water collected in houses supplied from four different sources showed in all cases that the water dissolves lead from the pipes, the quantity dissolved in some cases being sufficient to cause lead poisoning. At other seasons of the year and with other conditions it is not unlikely that even greater quantities of lead are dissolved from the pipes than at the present time.

The Board would advise that the lead pipes used to supply water to Gilbertville be removed without delay, and pipes substituted which will not be attacked by the water, or, if attacked, will not injure the health of those who use the water for drinking or cooking. The danger of lead poisoning can be avoided by the use of pipes of tin, of lead properly lined with tin, or of iron lined with tin or with cement.

Harvard.

March 3, 1904.

To Dr. William N. Cowles, *Ayer, Mass.*

Dear Sir: — In response to your communication of January 18 for an examination of certain wells in the town of Harvard which have been suspected of causing lead poisoning, the Board has caused samples of water to be collected from four wells indicated by you, the results of which are enclosed herewith.

The results of the analyses show that the water of all of these wells dissolves lead from the pipes, and the quantity of lead present in the samples collected from the Chace and Mongovan houses would be very likely to cause lead poisoning.

The Board would advise that the lead pipes used to supply the water in these two houses be removed without delay, and pipes substituted which

will not be attacked by the water, or, if attacked, will not endanger the health of those who use the water for drinking or cooking.

In the case of the other two houses it is possible that at other seasons of the year and under different conditions the quantity of lead taken up by the pipes would be larger than was shown by the recent analyses; and, to avoid danger of lead poisoning in these cases also, it would be advisable to remove the lead pipes and substitute other pipes which will not be acted upon by the water; but both of these wells are badly polluted, and it is desirable that the use of these sources be discontinued, and water introduced from some other source. Danger of lead poisoning can be avoided by the use of pipes made of tin, or of lead properly lined with tin, or of iron lined with tin or with cement.

Haverhill.

Jan. 5, 1905.

To the Board of Water Commissioners of the City of Haverhill.

Gentlemen: — In response to your request for information as to the cause of the offensive taste and odor of the water of Johnson's Pond, supplied to the Bradford district, the Board has caused examinations of the water, both of the pond and distributing system, to be made, and finds that the objectionable conditions are due to the organism *Uroglena*, which is present in the water of the pond in very large numbers. The Board is unable to advise you as to the cause of the presence of this organism in the water of the pond. It is not known whether the use for drinking of water containing this organism would be injurious to health, or not.

The city of Haverhill has other independent sources of water supply, which are not apparently at the present time affected by disagreeable tastes and odors; but no provision appears to have been made for supplying water from these sources on the Bradford side of the river. The Board would advise that one way of overcoming the difficulty is by connecting the works in the Bradford district with those on the Haverhill side of the river, so that it will be practicable to supply the Bradford district with water from one of the other sources at times when the water of Johnson's Pond is affected by disagreeable tastes and odors, as at present; and there might also be times when it would be desirable to use the water of Johnson's Pond in the portion of the city north of the river.

The Board would further advise that the objectionable tastes and odors could be removed from the water of Johnson's Pond by filtration; and this is the only safe and practicable way known to the Board of removing from this water the organisms and the objectionable taste and odor which they cause.

HOLLAND.

JULY 7, 1904.

To MR. A. F. BLODGETT, *Secretary of Water Committee, Holland, Mass.*

DEAR SIR: — In response to your request for an examination of the water of a certain spring in Holland and advice as to the use of this source for a water supply for a schoolhouse, town hall and one or two other buildings in the village, the Board has caused the spring and its surroundings to be examined by one of its engineers and samples of the water to be analyzed.

The results of the analyses show that the water is soft and colorless, and evidently of good quality for the purposes of a public water supply, provided that it be protected from the entrance of surface water, by which it was affected somewhat at the time the samples were collected for analysis.

The Board is unable to advise you as to whether the quantity of water which this spring will furnish will be sufficient for the requirements of the buildings and dwelling houses which are in need of a water supply. At the time the examination was made the spring was full, but little or no water was flowing away from it. It seems likely that, by excavating a well or basin at the spring and laying a pipe from near the bottom of the excavation, a sufficient flow of water for the village could be obtained at all times.

The Board would advise that, before laying a pipe to take a supply from this source, you cause a test of its yield to be made by drawing water from the spring daily in approximately the quantity that will be required for the supply of the village, and observe whether by this test the water returns and maintains its level, or whether the spring is gradually becoming exhausted. If, by such a test, the yield of the spring is found sufficient, the Board is of the opinion that the source will be a suitable one for the requirements of the village.

HOLYOKE.

NOV. 3, 1904.

To the Board of Water Commissioners of the City of Holyoke.

GENTLEMEN: — In response to your request for advice as to prevention of the pollution of Manhan Brook, one of your sources of water supply, by a group of farm buildings situated between two tributaries of the brook, a short distance north of the road leading from Westhampton to Norwich Hill, the Board has caused an examination of the locality to be made by one of its engineers, and has considered the plan presented.

An examination of the surroundings shows that the stream is now being polluted by foul drainage from the buildings; and the situation of these buildings is such that it is impracticable, under the existing conditions, to prevent the pollution of the stream from this place. The plan submitted provides for diverting the flow of the west branch of the stream, into which the drainage now finds its way, into the east branch at a point some

distance above the farm buildings, where the flow was evidently once diverted at some previous time. It is also proposed to put in a second channel immediately above the farm buildings, to divert any waters which may find their way into the bed of the west branch below the upper point of diversion.

It will probably be practicable, by carrying out this plan, to prevent any direct pollution of the brook from the farm buildings, and the cost of the necessary works will not be large. The situation of these buildings, however, is such that they will continue to menace the purity of the water at all times, and it is advisable, in the opinion of the Board, for the city to secure control of these buildings without delay, and prevent their further use. When this is done the Board would advise that rules and regulations be secured and enforced to protect the remaining part of this water-shed.

Holyoke (Holyoke Valve and Hydrant Company).

Aug. 4, 1904.

To Mr. John J. Sullivan, *Vice-President and Manager, Holyoke Valve and Hydrant Company, Holyoke, Mass.*

Dear Sir: — In accordance with your request of June 21 for an examination of the water of a tubular well at your factory, used for drinking by the employees and others, the State Board of Health has caused the well and its surroundings to be examined and several samples of the water to be analyzed.

The results of the analyses show that the water of this well has at some time been considerably polluted by sewage, but subsequently very well purified in its passage through the ground before entering the well. The quantity of organic matter present in the water is larger than is found in good ground waters, and, while this water is probably safe for drinking at the present time, changes in the height of the ground water or other circumstances may at any time render it unsafe, and the Board cannot recommend its continued use for drinking.

Holyoke (Whitmore Manufacturing Company).

Aug. 4, 1904.

To the Whitmore Manufacturing Company, Holyoke, Mass., Mr. F. D. Heywood, *Treasurer.*

Gentlemen: — In response to your request of July 11 for advice as to the quality of the water of a tubular well recently driven at your works in Holyoke, which it is proposed to use for drinking, the State Board of Health has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that this water, while it has been slightly polluted at some time before entering the well, and is somewhat hard, is in other respects of good quality and safe for drinking at the present time.

The well is located in a densely populated part of the city, however, and the quality of the water may change materially after a considerable quantity has been drawn from the well. It cannot be determined, until much more water has been drawn from the well, whether the water will continue to be safe for drinking; and, if used for that purpose, the water should be analyzed from time to time, and its use discontinued if the quality should seriously deteriorate.

Hull.

Jan. 5, 1905.

To the Board of Health of the Town of Hull.

Gentlemen: — The State Board of Health received on December 30 from Dr. W. H. Sturgis, physician to the board of health of the town of Hull, the following communication relative to the quality of the water supplied to that town: —

It is the desire of the Hull board of health that I ask your aid in determining the purity of the water supplied to the town for drinking and other purposes.

For about four weeks the water (which we understand is not the same previously supplied) has given off such an odor and has such a disagreeable taste that it is nearly impossible to drink it. There is also a large number of cases of diarrhœa, which may possibly come from the water.

The complaints from the people are so constant that we consider it our duty to determine the purity of this water.

In response to this request the Board has caused the sources of the water supplied by the Hingham Water Company to the towns of Hingham and Hull to be examined by one of its engineers and samples of water from the sources of supply and from faucets in Hull to be analyzed.

It appears from this examination that up to within a short time the water supplied to the town of Hull was drawn from a well and a system of pipes for collecting ground water near Fulling Mill Pond; and the results of analyses of this water show that it is clear and colorless, contains but little organic matter, and is otherwise of good quality for the purposes of a public water supply. This water was supplied by pumping, but recently the pumping machinery was shut down for repairs, and the towns have been supplied with water by gravity from Accord Pond in Hingham. An examination of the water of this pond shows that it contains the organism *Uroglena* in large numbers, and it is to the presence of this organism in the water that the offensive taste and odor complained of in Hull at the present time are undoubtedly due. The water supplied to Hingham and Hull from Accord Pond has been objectionable for the same reason in previous years.

The Board is unable to advise you as to the cause of the presence of this organism in the water of Accord Pond, or as to any safe plan for preventing its appearance and the objectionable taste and odor which it produces.

If an adequate pumping plant should be provided, it is probable that enough water could be obtained from the well and other works near Full-

ing Mill Pond for the supply of both towns under ordinary circumstances; but if not, the water of Accord Pond could be filtered through filters constructed near Fulling Mill Pond, and a water free from taste and odor could in this way be supplied at all times.

The Board will make a further investigation, to determine if possible whether the use of the offensive water now supplied to Hull is the cause of sickness, as suggested in the above communication, and will inform you of the results when the investigations are completed.

Ipswich.

Feb. 4, 1904.

To the Water Commissioners of the Town of Ipswich.

Gentlemen: — The State Board of Health, in accordance with your request for an examination of the storage basin of the public water supply of Ipswich, and advice as to improving the quality of the water, which has been affected at times by disagreeable tastes and odors, has examined the condition of the reservoir, and has made experiments during the past three years upon the purification of the water by intermittent filtration, using for this purpose two experimental filters constructed by you, which were well suited to the purpose. These filters contained above the underdrains about 5 feet of sand obtained in the neighborhood, and were operated at a rate of about 2,500,000 gallons per acre per day; the only difference in the operation of the two filters being that in one case the water was aerated before being applied to the filter, while in the other the water was applied directly as it came from the reservoir, but the effluent coming from this filter was aerated before being collected for analysis. A temporary filter was operated for a time at the town hall.

The water of Dow's Brook reservoir has been analyzed by the Board at frequent intervals since the reservoir was first used, in 1895; and an examination of the results of these analyses shows that this water has generally had but little color, and the quantity of organic matter present, while greater than found in some ponds and reservoirs, is not excessive.

The objectionable taste and odor of this water, which were the cause of much complaint in the earlier years and up to the time when these experiments were begun, were probably caused largely by the organisms which grow in abundance on the sides and bottom of the reservoir, especially near its upper end, and by microscopic organisms suspended in the water. The offensive taste and odor may have been due in part also to drawing water from the bottom of the reservoir, where, it is not improbable, a layer of stagnant water exists during the summer, as in many other ponds and reservoirs. During the time that these experiments have been continued the objectionable odor has apparently been less noticeable than in previous years, excepting in the early part of 1903, when the water had an offensive fishy and oily odor, due to the presence of the organism *Uroglena* in great numbers.

An examination of the results of the analyses of the water before and after filtration shows that the experimental filters operated in the manner described removed nearly all of the color from the reservoir water and a large portion of organic matter, and that the effluent was in all cases clear, nearly colorless and free from odor. During the time when the great quantity of *Uroglena* was present in the water, in the spring of 1903, the temporary filter set up in the town hall removed all of the taste and odor from the water during the short time when this water was affected by these organisms.

The results of the experiments and of investigations upon the purification of other waters similarly affected indicate that the objectionable taste and odor of the water of Dow's Brook reservoir can be removed, and the water made clear, odorless and practically colorless and satisfactory in all respects for domestic purposes, by filtration through sand at a rate as great as 2,500,000 gallons per acre per day.

Your attention was called by this Board in 1896 to the great danger of injury to the health of the people of the town by the pollution of the water of the reservoir and its tributaries by sewage and other wastes from the large number of dwelling houses and other buildings along its northwesterly side.

The results of a recent examination of this locality show that no material improvement has been made in these conditions, and that much sewage from the buildings referred to still finds its way into the reservoir.

It will be very difficult to prevent wholly the pollution of the reservoir from these buildings, but by filtering the water of the reservoir it will be practicable not only to greatly improve its quality and remove the disagreeable tastes and odors by which it is now at times affected, but also to protect the health of the town from the danger due to the pollution of the reservoir and its tributaries.

The Board would advise that filters be installed as soon as possible. The filters should be constructed under the direction of an engineer of experience in the design and construction of such works, and a sufficient area should be provided to allow for a considerable increase in the use of water by the town.

The Board will, upon application, advise you as to any plans for the purification of this water that you may desire to present.

LAWRENCE.

FEB. 17, 1904.

To the Lawrence Water Board, Lawrence, Mass.

GENTLEMEN: — The State Board of Health recognizes with great concern that the water of your reservoir is daily falling at such rate that if it continues two weeks longer there will arise the necessity of drawing water directly from the river without filtration, and thus repeating the terrible

experience of Butler, Pa., with its 1,247 cases and 68 deaths by typhoid fever from a similar cause.

The danger to the health of the community requires the application of extraordinary means of protection.

If, after doing all that can be done to get purified water through the filter, the supply is but three-quarters as much as the people draw from the reservoir, every effort must be made to prevent so great a draft.

The Board advises that a notice be put in the hands of every water taker in the city, urging him or her to save all that is possible in daily use, and warning them that, unless they get on with three-quarters the amount generally used, the lives of the people will be in peril.

Beyond this the Board advises the employment of a competent body of men to make a rapid house-to-house inspection, and cause the stopping of all waste by leaking faucets or water-closets and running of water by night; in short, by taking every means in your power to prevent the draft being greater than the supply.

To accomplish this for a few weeks appears to be the only method within your system of water works of averting a calamity.

If you find that enough cannot be saved, it may be practicable to obtain some help by temporary connections with the water works of neighboring towns.

APRIL 28, 1904.

To Hon. C. F. LYNCH, *Mayor*, Mr. E. L. ARUNDEL, *President of Water Board*, and Mr. M. F. COLLINS, *Superintendent of Water Works, Committee on Filter proposed by the International Sewage Disposal Company for the Water Supply of the City of Lawrence.*

GENTLEMEN: — The State Board of Health received from you on April 14, 1904, the following communication, submitting for the approval of this Board certain plans and specifications of a filter for the purification of the water supply of the city of Lawrence: —

At a meeting of the city council of this city, held March 7, a representative of the International Sewage Disposal Company was present, and made the following proposition: that the above-named company would construct a filter of one-half an acre for $30,000. This plant would filter 3,000,000 gallons per day, and the effluent to be satisfactory to the State Board of Health.

The board of aldermen, at a meeting held March 14, voted to have the above-named company draw plans and specifications for their proposed new filter, and submit the same to the water board and the committee on water works of the city council. The common council, at their meeting held March 21, concurred in the action of the board of aldermen.

On Monday, April 11, the water board and the committee on water works held a meeting in the common council chamber. Mayor Cornelius F. Lynch presided, and, after an examination of the plans and specifications prepared by the International Sewage Disposal Company, it was voted that a committee of three, consisting of Hon. C. F. Lynch, Mayor, E. L. Arundel, president of the water board, and M. F. Collins, superintendent of water works, present the above plans and

specifications to the State Board of Health for their approval; accordingly, we are forwarding you to-day the plans and specifications under separate cover.

Any information in regard to the working details of the plans will be furnished by John H. French, general manager, and C. D. Mitchell, consulting engineer, of the International Sewage Disposal Company.

The plans and the description of the proposed water purification plant filed therewith provide for pumping water from the Merrimack River into four sedimentation tanks, having a capacity of 250,000 gallons, in which the water is to be allowed to settle for a period of two hours; and for filtering the water, after passing through the tanks, upon a filter composed of sand, gravel and broken stone, having an area of 22,200 square feet and a depth of 5 feet of filtering material, the whole to be enclosed in a building provided with skylights.

The proposed filter is to be composed of a bottom course of broken stone 6 inches to 8 inches in thickness, containing pipes passing longitudinally through the filter, which it appears are intended to allow the passage of air into the filter. Above this is a layer of gravel 2 inches in thickness; then a layer of sand, described as "clean, sharp" sand, 30 inches in thickness; then another layer of fine gravel; then a 6-inch layer of broken stone, including more aerating pipes, so called; then a layer of fine gravel 2 inches deep; and finally a layer of fine sand 12 inches deep.

The filter is at such an elevation that the water from the river would have to be supplied to it by pumping, and, after passing through it, would apparently flow freely into the present pump well at the pumping station at all times.

The Board has carefully considered the plans and specifications and the descriptions submitted therewith, and finds that, as a means of purifying the water of the Merrimack River and protecting the health of the people of Lawrence from typhoid fever and other evils resulting from the use of unpurified or imperfectly purified river water for drinking, the proposed filter would, in its judgment, be entirely inadequate and unsuitable; hence, the Board declines to approve the plans and specifications submitted.

June 2, 1904.

To Hon. Cornelius F. Lynch, ***Mayor,*** **Edward L. Arundel,** ***President of Water Board,*** **and M. F. Collins,** ***Superintendent of Water Works, Lawrence, Mass.***

Gentlemen: — The State Board of Health received from you on May 9, 1904, the following communication relative to a proposed plan of purifying 6,000,000 gallons per day of Merrimack River water for the supply of the city of Lawrence: —

Your communication of April 28, in reply to our request asking for your opinion on the plans and specifications of the International Sewage Disposal Company, was read and accepted at a joint meeting of the water board and the committee on water works of the city council, held May 6.

At this meeting Mr. Chipman of the Chipman Electric Purifying Company of New York appeared, and made the following proposition: that his company would install a plant to purify 6,000,000 gallons per day, to include a 200 horse-power boiler; a 65 horse-power engine; a 50-kilowatt generator; three 2,000,000-gallon centrifugal pumps; switch boards, meters, etc.; three basins for purifying, 20 by 6 by 3 feet in size; three basins for clarifying, 30 by 6 by 4 feet in size; 180 electrodes, 6 by 3 feet by $\frac{7}{16}$ inch; 24 feet of 18-inch pipe laid; and 30 12-inch gate-valves, ready for use. All these would be furnished for approximately $20,000, exclusive of a building.

The cost for maintenance would be about $3,000 per year, $1,596 of which would be for additional electrodes. The water, which would be guaranteed to be clear and free from disease germs, and not over 2 per cent. in hardness, would cost approximately $2.55 per million gallons.

Mr. Chipman informed the committee that he would furnish bonds to the amount of the cost of the plant.

We were instructed to present the proposition of Mr. Chipman to the State Board of Health for their approval.

Owing to the short time that remains before the General Court adjourns, the committee feels that as prompt reply as would be consistent for your honorable body to give the proposed plans your due consideration would be appreciated.

Subsequently a model of the proposed purifying plant was delivered at the office of the Board by an agent of the Chipman Electric Purifying Company, and on May 19 the plans of the proposed works for purifying the water supply of the city of Lawrence were filed in this office.

Since the receipt of the model the Board has conducted experiments upon the effect of treating sewage-polluted water in the manner outlined in the plans and descriptions submitted by the Chipman Electric Purifying Company, and has carefully examined the plans of the proposed works and the information submitted therewith.

The essential features of the plans submitted are: (1) a receiving basin, so called, in which the water of the river will be received, and opportunity allowed for sedimentation; (2) purifying basins, through which the river water is to flow, containing electrodes composed chiefly of aluminum, through which an electrical current is to be passed; and (3) clarifying basins, so called, in which are four compartments, arranged transversely across the basin, which are to contain quartz or charcoal 2 feet in thickness, through which the water is expected to pass and be clarified, the arrested matter being discharged from the basin at intervals through outlets in the bottom. The water is expected to pass successively through these four filters or strainers, each 2 feet in thickness, and having an area of about 180 square feet.

The results of experiments upon the removal of sediment from the water of the Merrimack River at Lawrence by means of sedimentation basins show that very little of the organic matter in the river water would be removed in the proposed receiving basin. Experiments with the model

submitted show that the bacteria in the water would be only partially removed by the electrical process proposed, which is, in effect, chemical precipitation. In order to pass the water through the filters in the clarifying basins at the rate indicated, it would be necessary that they should be composed of exceedingly coarse material, which would preclude their operating efficiently as filters. The cost of operating such a plant, judging from the information available to the Board, would be many times greater than the cost of operating an ordinary sand filter.

In the opinion of the Board, the proposed electrical treatment would not destroy the harmful bacteria in the water, and a subsequent thorough filtration of the water would be necessary in order to effect its purification. Such filtration would not be accomplished by the proposed strainers.

Works constructed in accordance with the plans submitted would, in the opinion of the Board, be incapable of protecting the health of the people of Lawrence from the effect of a polluted drinking water, and the Board declines to approve the proposed plans.

Lawrence (Well at City Hall).

June 2, 1904.

To the Board of Health of the City of Lawrence, Mr. Roscoe Doble, *Clerk*.

Gentlemen: — In response to your request for an examination of the water of a well at the city hall in Lawrence and advice as to its quality, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water, though nearly clear and but slightly colored, is badly polluted, and a bacterial examination shows the presence of bacteria characteristic of sewage.

In the opinion of the Board, the use of water from this well would be liable to cause sickness, and the Board would advise that the possibility of the future use of this water for drinking be prevented.

Lawrence (Briggs & Allyn Manufacturing Company).

March 3, 1904.

To the Briggs & Allyn Manufacturing Company, Lawrence, Mass., Mr. Lewis P. Collins, *Agent*.

Gentlemen: — The State Board of Health received from you on Nov. 2, 1903, a communication requesting advice as to the quality of the water of a tubular well 195 feet deep, recently sunk on your premises at Lawrence, from which you propose to take water for drinking if the quality is found satisfactory; and in response to your request the Board has caused the well and its surroundings to be examined and several samples of the water to be analyzed chemically and bacterially.

The results of the analyses show that the water has at some time been slightly polluted, but subsequently well purified in its passage through the

ground before entering the well; and the Board is of the opinion that while its condition remains as at present this water may safely be used for drinking. The water should be analyzed from time to time, however; and if deterioration occurs, its use should be discontinued.

LENOX.

JULY 7, 1904.

To Mr. WILLIAM D. CURTIS, *Treasurer, Lenox Water Company, Lenox, Mass.*

DEAR SIR: — The State Board of Health has considered your communication of June 21, 1904, in which you state that organisms have reappeared in the storage reservoir from which the supply of Lenox is drawn, causing the water to have a very disagreeable taste and odor, and requesting advice as to whether this Board will recommend the application of sulphate of copper to this reservoir for the prevention of the trouble.

The method of treatment proposed has only recently been suggested as a possible means of removing the disagreeable tastes and odors caused by the presence of *Algæ* and similar water plants in the waters of ponds and reservoirs; and the tests which have thus far been made, in co-operation with the United States Department of Agriculture, have not been carried far enough to enable the Board to advise you either as to the efficacy of this treatment in preventing troubles from tastes and odors in your reservoir water, or as to what effect, if any, this method of treatment of a water supply reservoir might have upon persons or animals using the water for drinking.

The statement contained in your letter, that in one place where this method has been tried a certain kind of fish was killed, serves to indicate some of the objections to the use of this method until its effects have been well determined by experiments with ponds and reservoirs not used as sources of drinking water supply.

Experiments have shown that it is practicable to purify waters affected by disagreeable tastes and odors, such as render the water of the Lenox reservoir objectionable, by filtering the water through sand; and this method has the further advantage in this case, that, if properly carried out, it will prevent danger of injury to the health of those who use the water for drinking, which might now be caused by pollution finding its way into the water from the farm buildings and cultivated lands on this water-shed.

The Board believes that in the case of the Lenox reservoir filtration of the water will be, all things considered, the best practicable method of preventing the disagreeable tastes and odors caused by organisms, and the danger arising from possible pollution of the water from the buildings within the water-shed.

LENOX (NEW YORK, NEW HAVEN & HARTFORD RAILROAD COMPANY).

SEPT. 1, 1904.

To the Superintendent of the Berkshire Division of the New York, New Haven & Hartford Railroad Company.

DEAR SIR: — In response to the request of Mr. H. W. Fenn, agent at the Lenox station of the New York, New Haven & Hartford Railroad Company, for advice as to the probable effect of proposed works for the disposal of the sewage of Lenox, located near the present source of water supply of the station, upon the quality of the water, the Board has caused the locality to be examined by one of its engineers and has caused samples of the water to be analyzed.

It appears that the supply is now drawn from a spring, so called, near a brook flowing near the sewage disposal area of the town of Lenox, the water being evidently derived, in part at least, from the brook.

Analyses of the waters of the spring and brook indicate that they have been slightly polluted, but it does not appear that the sewage or effluent from the Lenox sewage disposal works was finding its way into your source of supply at this time. The proposed new filters, if underdrained so as to convey the effluent away from the neighborhood of the brook, would probably not affect your water supply; but if the lands near the northerly limit of the area owned by the town, which appear to contain better soil for sewage disposal than other parts of the area, should be used, the Board is of the opinion that your source of water supply might be affected.

LONGMEADOW.

APRIL 7, 1904.

To the Board of Water Commissioners of the Town of Longmeadow.

GENTLEMEN: — The State Board of health received from you on March 28, 1904, a petition for the approval by this Board of the taking of certain lands in Longmeadow for the protection of the water supply of the town, accompanied by a plan and description of the proposed takings, and the Board has caused the locality to be examined by one of its engineers and has considered the plan of these areas presented.

The areas indicated, with the exception of very small portions, are within the water-shed of Cooley Brook, from which the water supply of Longmeadow is now drawn; and, in the opinion of the Board, it is essential that the town should control these areas in order to adequately protect its source of water supply; and the Board hereby approves the taking by the town of Longmeadow of the lands shown upon the plan submitted with this application, said lands being bounded, measured and described as follows: —

Daniel Castle Tract.

Beginning at a point in the northerly line of the Bliss Road, and at the division line of land of Daniel Castle and Harriet M. Bliss, and running thence north-easterly along said division line about 786 feet to the land of Ethan Ely.

Thence south-easterly along division line of land of Ethan Ely and Daniel Castle about 997 feet to a point.

Thence southerly along the division line of land of Ethan Ely and Daniel Castle about 415 feet to the northerly line of the Bliss Road.

Thence westerly along the northerly line of the Bliss Road about 1,190 feet to the point of beginning.

The above-described parcel of land contains about 15.45 acres.

Ethan Ely Tract.

Beginning at a point on the division line of land of Judge Patrick Casey, heirs G. Hooker and Ethan Ely, and running thence easterly on the continuation of the division line of land of said Casey and Hooker about 1,560 feet to a point.

Thence southerly on land of said Ethan Ely about 968 feet to land of Daniel Castle.

Thence north-westerly along division line of land of said Daniel Castle, Ethan Ely and Harriet M. Bliss, about 1,837 feet to a point on the division line of lands of said Ethan Ely, Harriet M. Bliss and town of Longmeadow.

Thence northerly along division line of lands of said Ethan Ely, town of Longmeadow and heirs of G. Hooker, about 421 feet to the point of beginning.

The above-described parcel of land contains about 24.63 acres.

Heirs of George Hooker Tract.

Beginning at a point on the division line between land of heirs of G. Hooker and land of town of Longmeadow, said point being about 275 feet distant easterly from the easterly line of Main Street, and running thence northerly about 336 feet on land of said Hooker to a point on division line between land of said Hooker and land of Judge Patrick Casey, said last-mentioned point being distant about 294 feet easterly from the easterly line of Main Street

Thence easterly along division line of lands of said Casey and said Hooker about 1,080 feet to a point, said point being at the division line of lands of said Hooker, Casey and Ethan Ely.

Thence southerly along division line of lands of said Hooker and Ely about 320 feet to a point in the division line of lands of said Hooker, Ethan Ely and town of Longmeadow.

Thence westerly along division line of lands of said Hooker and said town of Longmeadow about 1,215 feet to the point of beginning.

The above-described parcel of land contains about 8.24 acres.

Martha B. and Mary E. Cooley Tract.

Beginning at a point in the division line of land of town of Longmeadow and land of Martha B. and Mary E. Cooley, said point being distant easterly about 690 feet from the easterly line of Main Street, and running thence easterly along division line of land of said town of Longmeadow and land of said Cooley about 735 feet to a point, said point being at the division line of land of said town of Longmeadow, Cooley and Harriet M. Bliss.

Thence south-westerly along division line of said Harriet M. Bliss and Cooley about 360 feet to a point in said division line.

Thence north-westerly along said division line about 625 feet to a point.

Thence northerly on land of said Cooley about 420 feet to the point of beginning.

The above-described parcel of land contains about 6.27 acres.

Harriet M. Bliss Tract.

Beginning at an angle point in the northerly line of the Bliss Road, and running thence northerly on land of Harriet M. Bliss about 467 feet to a point.

Thence north-westerly and in range with the southerly division line of land of Martha B. and Mary E. Cooley and Harriet M. Bliss about 500 feet to a point at the south-easterly corner of said Cooley land.

Thence northerly along division line of land of Harriet M. Bliss, Cooley and town of Longmeadow, about 767 feet to a point on the division line of land of Ethan Ely, Harriet M. Bliss and town of Longmeadow.

Thence south-easterly along division line of land of Ethan Ely and Harriet M. Bliss about 840 feet to a point in the division line of land of Ethan Ely, Daniel Castle and Harriet M. Bliss.

Thence south-westerly along division line of land of Daniel Castle and Harriet M. Bliss, about 786 feet to the northerly line of the Bliss Road.

Thence westerly along the northerly line of the Bliss Road about 26 feet to the point of beginning.

The above-described parcel of land contains about 10.44 acres.

The examination made by the Board shows that there are buildings within the water-shed of the brook not included in these takings; and it is very desirable, in the opinion of the Board, that the town should secure control of such further areas within the water-shed of this brook as are liable to become inhabited.

MAYNARD.

FEB. 4, 1904.

To the Board of Water Commissioners and the Board of Health of the Town of Maynard.

GENTLEMEN: — The State Board of Health is informed that water for the supply of Maynard has been drawn at times during the past year from a brook flowing near your pumping station, at a point a short distance above the place where this stream joins the Assabet River.

The Assabet River at Maynard is seriously polluted by sewage, and there is great danger that in drawing water from the brook, polluted river water may, under some conditions, be drawn into your water supply system.

If the supply of water from White Pond, the source now used, is inadequate, or if the pipe which conveys the water is too small for the requirements of the town, an adequate supply of good water should be provided without delay.

FEB. 4, 1904.

To the Board of Health of the Town of Maynard.

GENTLEMEN: — Your attention is called to the fact that, while water from the Maynard water works is supplied for drinking in the mills of the American Woolen Company, the polluted water of the Assabet River is also supplied for washing and other purposes in these mills; and that the faucets of the two systems are in many places side by side or close to-

gether, with no adequate means by which the operatives may distinguish between the town water and the polluted river water.

An examination of the causes of an exceptionally large number of cases of typhoid fever among the operatives in these mills recently showed that the disease was probably caused by the drinking of polluted river water supplied in these mills. The Board would advise that, if it is necessary that river water shall be provided in these mills where it may be used for drinking, the faucets through which it is supplied should be marked in such a way that they may be readily distinguished from those connected with the town supply; and the operatives and others who have access to them should be instructed as to the danger of using the water from faucets connected with the river supply for drinking.

MERRIMAC.

MARCH 3, 1904.

To Messrs. EVERETT D. GEORGE, FRANK E. PEASE and WILLIAM L. SMART, *Board of Water Commissioners of the Town of Merrimac.*

GENTLEMEN: — The State Board of Health received from you on Feb. 23, 1904, an application for the advice and approval of this Board, under the provisions of chapter 281 of the Acts of the year 1903, of a proposed source of water supply, which is described in your application as follows: —

It is proposed to develop a ground water supply at "The Plains." Wells have been driven at this place, sixteen of which have been connected together and to a steam pump. A pumping test of two weeks' duration has been made on these wells, and observations were taken during the pumping test on six other wells driven in different locations in the vicinity, but not connected with the pump. In the final plan of construction it is proposed to use the sixteen wells which were connected to the pump, driving others if it is necessary to obtain a sufficient supply.

It is proposed to locate the pumping station at such a point that water can be drawn from Kimball's Pond by suction and pumped upon the land in the vicinity of the wells, with a view of increasing the supply by natural filtration through the ground, if the growth of the town and the consumption of water demand in future a greater supply than that naturally furnished by the wells. This water will be pumped into a stand-pipe which will be covered to exclude the light.

The location of the wells already driven is shown on a plan accompanying this application.

The Board has already considered the proposed source and the information available concerning the quantity and quality of water to be obtained therefrom, in response to an application of a water supply committee of the town; and on Jan. 7, 1904, advised the committee as follows: —

The Board has carefully examined the plans and information submitted therewith, and the results of analyses of numerous samples of water collected before and during the pumping test.

The information submitted to the Board shows that water was pumped continuously from the wells at a rate of not less than 300,000 gallons per day for a period of two weeks, and that during this time the water in the ground about the wells lowered less than 2 feet, and less than a foot in any of the test wells in which measurements were made; and considering the circumstances, the Board is of the opinion that an adequate supply of water for the present requirements of Merrimac can be obtained from the ground where this test was made.

It is probable that a larger supply could be obtained, if necessary, by extending the wells over a somewhat larger area; though care will be necessary, in locating new wells, to avoid using wells in localities containing an excessive quantity of organic matter or iron. If in future, on account of the growth of the town or increase in the use of water, a larger supply is found necessary than wells in this locality are capable of furnishing, a larger supply can doubtless be obtained without special difficulty by filtering the water of Kimball's Pond, either in the manner proposed in your application or by some other plan.

The quality of the water of the test wells, as shown by the results of analyses of numerous samples collected during the pumping test, is excellent for all the purposes of a public water supply; and, if the water shall be kept from exposure to light until delivered to consumers, as proposed in your plan, its quality should remain satisfactory.

In the opinion of the Board, the information furnished by your recent tests shows that a sufficient supply of good water for the town of Merrimac can be obtained from the ground at the locality in which the recent tests were made, and the Board approves the adoption of this source.

The Board hereby approves the use of the proposed source of water supply for Merrimac, under the provisions of chapter 281 of the Acts of the year 1903.

MILLBURY (E. G. HOWE).

JULY 7, 1904.

To Mr. E. G. HOWE, *Millbury, Mass.*

DEAR SIR: — In response to your request for an examination of a spring in Millbury from which you are taking water to sell for drinking, the Board has caused the spring and its surroundings to be examined and samples of the water to be analyzed.

The results of the recent analyses show, when compared with analyses made in previous years, that very little change has taken place in the quality of the water, and, in the opinion of the Board, this water is safe for drinking at the present time.

The Board would advise that the pump which has already been connected with the spring be used in the filling of all receptacles in the future, and the possible danger of the contamination of the spring, caused by the present method of collecting the water, avoided.

It is also desirable that further provision be made to prevent the entrance of surface water from the driveway above the spring, since it is possible that, at times of very heavy rain, water from this driveway might find its way into the spring.

By making the changes suggested, the water of this spring may, in the opinion of the Board, safely be used for drinking while the conditions about it remain as at present.

MILTON (HOUGHTON SCHOOL).

NOV. 3, 1904.

To the Board of Health of the Town of Milton, DR. A. W. DRAPER, *Secretary*.

GENTLEMEN: — In accordance with your request of October 20 for an examination of the well at the Houghton school, and advice as to the quality of the water, the Board has caused the well to be examined and samples of the water to be analyzed.

The well is situated in the lower part of the grounds, while the school and its outbuildings are in the higher portions. The water when examined had a disagreeable odor, and the chemical and bacterial analyses show that it is evidently being polluted.

In the opinion of the Board, the water is unsafe for drinking, and its further use as a source of drinking water supply should be prevented.

MILTON (LEOPOLD MORSE HOME).

DEC. 1, 1904.

To the Trustees of the Leopold Morse Home, Mattapan, Mass., MR. SOLOMON SCHINDLER, *Superintendent*.

GENTLEMEN: — In response to your request for an examination of the water of a well upon the grounds of the institution at Mattapan, and advice as to the quality of the water, the Board has caused an examination of the well to be made and a sample of the water analyzed.

The water is turbid, has an unpleasant odor, and has evidently been considerably polluted by sewage and not well purified in its subsequent passage through the ground. There are sources of pollution in the neighborhood of the well, and, in the opinion of the Board, the water is unsafe for drinking.

NORTHAMPTON.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on June 2, 1904, for preventing the pollution and securing the sanitary protection of the sources of water supply of the city of Northampton.

NORTH ATTLEBOROUGH.

JULY 7, 1904.

To the Board of Water Commissioners of the Town of North Attleborough.

GENTLEMEN: — The State Board of Health has considered your application for advice with reference to increasing the water supply of North Attleborough by taking water from a large dug well, to be located near the Ten Mile River in Wrentham below Fuller Street, and has caused the lo-

cality to be examined by one of its engineers and samples of water from test wells in this region to be analyzed.

The information furnished to the Board concerning the test wells recently driven in the valley of the brook below Fuller Street indicates that strata of fine material were encountered in many of these wells, and that ledge is found not far beneath the surface; so that the indications furnished by many of these wells are unfavorable to obtaining water freely from the ground in such quantities as would be necessary for the supply of North Attleborough.

The most favorable conditions were found in two test wells located a little more than half a mile below Fuller Street on the easterly side of the railroad, near the brook, a short distance below the site of an abandoned dam. The material encountered at this place was coarse and porous to a considerable depth, and water could be pumped from these wells very freely.

Samples of water collected and sent in by you from the various wells all contained considerable quantities of clay and sand; and it is impracticable to determine satisfactorily from these samples the probable quality of the water obtainable from the ground in this region, though the results indicate that the water would be of good quality unless it should be affected by an excess of iron.

The Board would advise that additional wells be put in in the neighborhood of the test wells located near the old dam, and that a pumping test be made by pumping from these wells for a period of a week or more at a rate at least as great as would be required for the supply of North Attleborough; and that observations be made, during this test, of the effect of the pumping upon the height of the ground water in the neighborhood of the wells. Samples of water should also be taken from time to time during the test, in order to determine its probable quality.

The Board will assist you in these investigations, if you so request, by making the necessary analyses of samples of water, and will give you further advice when the results of further tests are available.

SEPT. 1, 1904.

To the Water Commissioners of the Town of North Attleborough, Mr. J. F. MAKINSON, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Aug. 18, 1904, an application for advice with reference to a proposed additional water supply for the town of North Attleborough, accompanied by a statement of the results of further tests of the ground in the neighborhood of the Ten Mile River above the village of Plainville in Wrentham, as advised by the Board in response to your previous application. The tests are described in your application as follows: —

The town of North Attleborough is about completing a pumping test from 13 2-inch driven wells, averaging 25.8 feet deep. Pumping was begun Aug. 5, 1904,

and has been continuous since the morning of August 6. It is proposed to close the test at 5 P.M. to-day, August 17, a total of about two hundred and seventy-four hours.

The pumpage at the start was at the rate of about 370,000 gallons per twenty-four hours, but has been increased, so that for the latter part of the test it has been at the rate of 738,000 for several days.

Readings of the depth over a 30-inch weir have been taken every fifteen minutes. Records of the height of the water in an observation well, located in the immediate vicinity of the 12 wells pumped from, have also been made. At the beginning the water stood 15¾ inches below the top of the pipe of the test well, which is 14¾ inches above the surface of the ground; at the close of the test the water stood 49½ inches below the top of the pipe.

The temperature by a standard thermometer, at 10 A.M., August 15, of the water at the weir tank, was 51°; Ten Mile River at same time, 59°; air, 80°.

Samples of water from the weir tank, representing a mixture from all the 12 wells, have been sent you for analysis every day.

Several samples of water collected and sent in by you from time to time during the test have been analyzed by the Board, and the Board has also caused the locality to be examined by one of its engineers.

The results of observations upon the height of water in a well near the test wells show that the ground water went down rapidly in the beginning of the test, but more slowly later, even when a larger quantity of water was being drawn, and the recovery of the water after pumping had ceased was rapid; and, judging from the results of the observations submitted, the Board is of the opinion that it is practicable to obtain from the ground at this place a large quantity of water, sufficient to meet the requirements of North Attleborough in the matter of water supply for a long time in the future, unless the increase in the use of water shall be at a materially greater rate than in the past ten years.

The results of the analyses of samples of water collected during the test show that the water is clear, colorless and odorless, and otherwise of excellent quality for the purposes of a public water supply. A portion of the test wells, however, were located in the low land close to the brook, where there is in some places a depth of several feet of mud. It will be necessary, in order to avoid danger of deterioration in the quality of the water, to locate the permanent works in the upland farther from the stream, and this can be done without special difficulty.

While the wells are located at no great distance from the village of Wrentham, it is unlikely that the quality of the water will be noticeably affected by sewage discharged upon or into the ground in this village, unless the territory nearer the wells should become populated. If the village should have a tendency in the future to grow in the direction of the wells, it would be desirable for the town of North Attleborough to secure control of lands in the neighborhood of the wells before the region becomes more thickly populated.

In the opinion of the Board, water of excellent quality can be obtained from the ground, in the locality in which the recent tests were made, by means of tubular wells or other suitable works, and the quantity obtainable would form a large addition to the available water supply of the town.

Northborough (Almshouse).

May 5, 1904.

To the Board of Selectmen and Overseers of the Poor, Northborough, Mass.

Gentlemen: — In accordance with a request of the State Board of Charity for an examination of the condition of a well used as a source of water supply at the almshouse in Northborough, the State Board of Health has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that this water is very foul, having evidently been grossly polluted by sewage from the house, and probably also by foul drainage from other sources in the neighborhood.

The Board would advise that the possibility of further use of water from this well for any purpose be prevented, and that a supply of water be provided from an unpolluted source.

Peabody.

May 5, 1904.

To the Committee on Water Supply of the Town of Peabody, Mr. H. F. Walker, *Chairman.*

Gentlemen: — In response to your request for the consent and approval of the State Board of Health, under the provisions of chapter 185 of the Acts of the year 1904, for the taking of certain lands bordering Spring Pond in the town of Peabody, the Board, in accordance with the provisions of the above-mentioned act, gave a public hearing at its office, room 141, State House, on Thursday, April 28, 1904, notice of which was given by publication in a newspaper published in the city of Salem.

After this hearing the Board voted to approve the taking of certain lands in the water-shed of Spring Pond in the town of Peabody, described as follows: —

Estate of R. S. Fay, Grantor. Town of Peabody, Grantee.

A certain parcel of land situated in Peabody, and bounded and described as follows: —

Beginning at a point at the angle of Spring Pond dam, so called, and running N. 24° 10′ W. by land of grantee fifty-five feet more or less to a stone wall; thence N. 76° 10′ W. along said wall by land of Wm. Brown two hundred thirty-three feet more or less; thence S. 33° 20′ W. by land of grantor nine hundred seventy feet more or less to a point on a stone wall; thence S. 76° 25′ E. along said wall by land of F. L. Newhall a distance of one hundred and sixty feet more or less to the shore of Spring Pond; thence north-easterly along shore of said pond to the point of beginning, and containing three and eighty-two one hundredths (3.82±) acres more or less.

Estate of F. L. Newhall, Grantor. Town of Peabody, Grantee.

A certain tract or parcel of land situated in the town of Peabody, and bounded and described as follows: —

Beginning at a stone monument on the west shore of Spring Pond, which is the intersection of the division lines between the town of Peabody and the cities of Lynn and Salem, and running along a stone wall between said Lynn and Peabody a distance of two hundred and seventy feet more or less by land of R. S. Fay and Isaiah Graves; thence N. 24° 10′ W. by land of grantor a distance of five hundred ninety-three (593±) feet more or less to a point; thence N. 72° 35′ E. by land of grantor nine hundred thirty feet more or less to a point; thence N. 80° 35′ E. by land of grantor a distance of four hundred forty-four (444±) feet more or less to a point on a stone wall; thence S. 76° 25′ E. along said wall by land of now or formerly R. S. Fay a distance of one hundred sixty (160±) feet more or less to the shore of Spring Pond; thence along the shore of Spring Pond in a south-westerly and south-easterly direction to the point of beginning; and containing twelve and nine-tenths (12.9±) acres more or less.

PEABODY (F. T. MOORE).

OCT. 6, 1904.

To Mr. F. T. MOORE, *589 Essex Street, Lynn, Mass.*

DEAR SIR: — In response to your request of August 31 for an examination of the water of a well on Lowell Street in West Peabody, from which you state it is your intention to sell water for drinking and family use if the quality is satisfactory, the State Board of Health has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of this analysis show that the water has at some time been polluted, and has not been purified before entering the well, the sample containing a larger quantity of organic matter and a larger number of bacteria than are found in ground waters from unpolluted regions. There are buildings in the immediate neighborhood of the well from which the pollution is evidently derived, and, in the opinion of the Board, this well is not a safe source of water supply.

PLYMOUTH.

FEB. 4, 1904.

To the Board of Water Commissioners of the Town of Plymouth.

GENTLEMEN: — In response to the request from your office received January 11, for an examination of the water of Great South, Little South and Lout ponds, which you state is at present affected by a bad taste and odor, and advice as to its quality, the Board has caused the sources mentioned to be examined and samples of their waters to be analyzed.

The results of the analyses show that the offensive taste and odor of the water at the present time are due to the presence of the organism *Uroglena* in the waters of Little South and Lout ponds. The cause of the appear-

ance of this organism in water is not known, and the Board knows of no practicable method of preventing its appearance and growth in the waters of ponds and reservoirs used as sources of public water supply. Water containing this organism is not known to be dangerous to health if used for drinking, but the offensive fishy and oily odor which the organism imparts to water frequently renders it unfit for this purpose.

In response to an application from the water commissioners of Plymouth in 1895 for advice as to the best method of preventing the objectionable conditions resulting from the presence of this organism in the water supply of Plymouth, and of improving the quality of the water, the Board advised that the conditions in the vicinity of the ponds from which your present supply is drawn appear to be favorable for obtaining water freely from the ground by means of wells or filter-galleries, and advised that you make an investigation as to the practicability of obtaining a water supply for the town by this plan and avoid the direct use of water from the ponds. A copy of this communication is enclosed herewith.

The Board would again advise that you investigate the practicability of securing a supply of ground water for the town, and avoid the frequent trouble from offensive tastes and odors in the water supply of the town, resulting from the presence in the water of *Uroglena* and other organisms.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on May 5, 1904, for preventing the pollution and securing the sanitary protection of the sources of water supply of the town of Plymouth.

Randolph and Holbrook.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on July 7, 1904, for preventing the pollution and securing the sanitary protection of the waters of Great Pond and its tributaries, used by the towns of Randolph and Hol brook as a source of water supply.

Shelburne.

July 7, 1904.

To the Committee on Water Supply of the Shelburne Falls Fire District, Mr. W. S. Ball, *Chairman.*

Gentlemen: — The State Board of Health has considered your application for advice with reference to the use of Clark Brook in the town of Buckland as a source of water supply for the Shelburne Falls Fire District, and has caused the water-shed of this stream to be examined by one of its engineers and several samples of the water to be analyzed.

The water, as shown by these analyses, is naturally of good quality for the purposes of a public water supply, but the water-shed of the brook is

found, upon examination, to contain several groups of farm buildings, some of which are located close to the stream; and if this brook should be used as a source of public water supply, it would be difficult to prevent the pollution of the water by sewage and other wastes from these buildings. If the buildings nearest the stream and its tributaries should be secured by the fire district, which might perhaps be done at a reasonable expense, the Board is of the opinion that this stream could safely be used as a source of public water supply.

No definite information is available as to the flow of Clark Brook in the drier portion of the year; but it appears, from an examination of the water-shed, that it is practicable to build a reservoir of considerable size in this valley if necessary, and an adequate supply of water for Shelburne Falls can evidently be obtained from this water-shed.

In view of the possible objections to the use of Clark Brook as a source of public water supply, the Board has caused examinations to be made of other streams in the neighborhood of Shelburne Falls.

Examinations of the waters of Wilder River, so called, in the town of Colrain, show that the water of this source is much softer than that of Clark Brook or any of the other brooks that were examined in this region; but this water-shed also contains a considerable population, and the source has the disadvantage that it is located at a considerably greater distance from the village than is Clark Brook.

Dragon and Sluice brooks in Shelburne were also examined, Sluice Brook having a decided advantage over Dragon Brook in the quality of its water and in other respects. The water-shed of Sluice Brook contains about the same population as that of Clark Brook; but the buildings are situated at greater distances from the streams, and the water could probably be protected from pollution with less difficulty and expense than in the case of Clark Brook. The area of the water-shed is about the same as that of Clark Brook, but the stream is about three-fourths of a mile farther from the village.

A tributary of Bear River in the southerly part of Buckland was also examined. The waters of this stream might be taken at a point above a highway in the north-easterly part of the town of Ashfield, and the drainage area above this point is somewhat greater than that of Clark Brook. The water-shed of the stream contains but three dwelling houses, which are located well away from the streams, and this water-shed could be more easily protected from pollution than any of the others examined. Its water is of about the same quality as that of Clark Brook, but the distance from the village is greater, and a pipe line about one and three-fourths miles longer would be required if this source should be used.

The Board is of the opinion that Clark Brook would be an appropriate source of supply for Shelburne, provided the dwelling houses and buildings which are located near the streams in this water-shed could be pur-

chased and removed, and danger of pollution from these places prevented; and, in estimating the cost of a supply from this source, the cost of the purchase and removal of these buildings should be included. Under the circumstances, the cost of a supply from this source might be greater than the cost of a supply from the tributary of Bear River or from Sluice Brook; and the Board would advise, therefore, that a careful estimate be made of the probable cost of works from each of those sources, including the probable cost of adequate protection of the waters from pollution.

When the results of further investigations are available the Board will, upon application, give you further advice in this matter.

SHREWSBURY.

MAY 5, 1904.

To Messrs. H. A. MAYNARD, R. E. ALLEN and W. H. RICE, *Water Commissioners of the Town of Shrewsbury.*

GENTLEMEN: — In response to your request of April 21 for the approval by this Board of a certain source of water supply for the town of Shrewsbury, the Board has caused the source indicated by you — a well located in the rear of one of the schoolhouses and near the public library in Shrewsbury — to be examined by one of its engineers and a sample of the water to be analyzed.

It appears from the information available to the Board that this well was sunk chiefly in rock, and the conditions are such that it is very doubtful whether the quantity of water which the source will yield would be sufficient for the requirements of the village in the drier portions of the year.

The results of an analysis of a sample of the water of the well show that it contains an excessive quantity of iron, which would make it very objectionable for many domestic purposes, and that it has been polluted by sewage and not thoroughly purified; and the Board does not approve the use of this well as a source of water supply for Shrewsbury.

There are several localities in the neighborhood of the village from which it may be practicable to obtain an adequate supply of good water by means of tubular wells, and the Board would advise that further tests be made, with a view to obtaining a supply of good water from the ground. It is not advisable to attempt to secure water by sinking wells in rock or in very compact soil.

SOMERVILLE (M. W. CARR & Co.).

OCT. 6, 1904.

To Messrs. M. W. CARR & Co., *Somerville, Mass.*

GENTLEMEN: — In response to your request for an examination of the water of a cistern and two tubular wells located at your factory, from which water is used for drinking and other purposes, the State Board of Health has caused the sources indicated to be examined and samples of their waters to be analyzed.

The large well is used as a cistern for the storage of roof water, and when examined evidently contained much rain water. The water was found to contain an excessive quantity of organic matter, and is not, in the opinion of the Board, suitable for drinking.

The tubular wells are located in a populous region, and the water has at some time been considerably polluted; and, although well purified in its subsequent passage through the ground, it is very hard, and is not a desirable drinking water. The quality of such waters is liable to deteriorate with a change in the conditions affecting their pollution, and the Board cannot advise the use of these wells as sources of drinking water supply.

Springfield.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on June 2, 1904, for preventing the pollution and securing the sanitary protection of the waters of Jabish, Broad and Axe Factory brooks, Ludlow reservoir, Chapin and Five Mile ponds and their tributaries, used by the city of Springfield as sources of water supply.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on Nov. 3, 1904, for preventing the pollution and securing the sanitary protection of the waters of Higher Brook and the lower basin of Van Horn reservoir and their tributaries, used by the city of Springfield as sources of water supply.

July 7, 1904.

To the Board of Water Commissioners of the City of Springfield, Mr. C. L. Goodhue, *Chairman.*

Gentlemen: — The State Board of Health has considered your application of June 20 for information as to the quality of the waters of Chapin and Five Mile ponds in the city of Springfield, and advice as to whether these ponds are suitable for use as sources of water supply for the city at the present time, and has caused the ponds and their surroundings to be examined by its engineer.

These ponds have already been used as sources of water supply for the city of Springfield from time to time for several years, and many analyses of their waters have been made during the last seven years, the results of which show that the waters of both sources are soft and nearly colorless, and otherwise naturally of good quality for the purposes of a public water supply.

Experience in the use of these waters has already shown that they are affected occasionally by disagreeable tastes and odors, due to the presence of certain microscopic organisms which are present at times in considerable numbers in these waters; but waters affected in this way are not known to be injurious to health when used for drinking or cooking.

Each of these ponds is situated in a sandy plain, and the limits of their water-sheds are indefinite. The water-shed of Chapin Pond may possibly contain one dwelling-house; but the circumstances are such that it is improbable that polluting matters deposited in or upon the ground at this place could find their way into the pond, unless by percolation for a long distance through the ground, in which case they would undoubtedly be thoroughly purified.

The only danger of pollution to which this source appears to be exposed at the present time is that which may be caused by visitors, chiefly in the summer season, who resort to the pond for bathing, fishing, etc.; and danger of the pollution of the water from this cause can be prevented without difficulty.

The water-shed of Five Mile Pond contains two dwelling houses, and it is possible that the ground water from the neighborhood of a third dwelling house, including adjacent barns and out-buildings, may percolate toward the pond. When the two dwelling houses nearest the pond were examined, the sewage and drainage were being cared for in vaults and cesspools; and the conditions are such that it is improbable that polluting matters from these premises find their way into the pond, unless by percolation through the ground, in which case they would undoubtedly be well purified before entering the pond. Drainage from the third dwelling house, together with the out-buildings, if it enters the pond at all, must percolate for a much longer distance through the ground than from the other two places. There appears to be no danger, under present conditions, of the pollution of the pond from any of these premises in such a manner as to render the water injurious or unsafe for drinking.

The arm of the pond near which the dwelling houses are situated is shallow, and contains a considerable growth of lilies and other organic matters, which doubtless have an unfavorable effect upon the quality of the water; and it is desirable to cut off this arm from the remainder of the pond by means of a dike, as you have suggested.

There is a picnic ground upon the shore of Five Mile Pond, and the pond is used to some extent as a resort for boating and fishing; and the only serious danger of pollution of the waters of this source at the present time is that which might be caused by this use of the pond and its shores.

In the opinion of the Board, there are no conditions existing about Chapin or Five Mile ponds, or within the water-shed of either pond, which would render the water of these sources unsafe for drinking if existing laws and regulations are enforced.

AUG. 8, 1904.

To the Board of Water Commissioners of the City of Springfield.

GENTLEMEN: — Your communication of June 1, 1904, requesting the advice of the State Board of Health as to a proposed experiment at the Ludlow reservoir for the removal of the organisms which render that source

objectionable, to be made under the direction of this Board, in co-operation with Dr. George T. Moore of the United States Department of Agriculture, has been considered by the Board.

At the time your request was received *Anabæna* had not yet appeared in considerable numbers either in Ludlow reservoir or in any source available for experiment. About the middle of July the organism began to appear in large numbers in the Belchertown reservoir, formerly a part of your system of water supply, but not now used; and arrangements were then made with Dr. Moore to make an experiment as to the effect of treating this reservoir with copper sulphate for the removal of the *Anabæna*, and a solution of copper was applied to the reservoir under the direction of Dr. Moore July 21. Many samples of the water were collected for analysis from the reservoir before treatment, and again twenty-four hours after the treatment, and other samples have been collected since that time. The numbers of *Anabæna* present in the water decreased materially within twenty-four hours after the copper sulphate was applied, and the organism subsequently disappeared from the reservoir; but the quantity of copper remaining in the water twenty-four hours after the treatment was found to be nearly equivalent to the quantity applied.

The Board regards it as essential to determine what becomes of the copper before applying it to a reservoir used, or liable to be used, as a source of drinking-water supply; and the Board cannot advise the application of this substance to the water of the Ludlow reservoir until its probable effect is more definitely known. Abandoned reservoirs are available and are being used by the Board for further investigation, and other necessary experiments are being made; but from present appearances safe conclusions can hardly be reached for use during the present season.

Springfield (Springs).

July 7, 1904.

To the Board of Health of the City of Springfield, H. C. Emerson, M.D., *Clerk.*

Gentlemen: — In response to your request for advice as to the safety for drinking purposes of the water of the Hygeia Spring, the Massasoit Spring, the Iroquois Spring and the Wilbraham Mountain Spring, from which it is proposed to distribute water for drinking in the city of Springfield, the Board has caused the springs to be examined and samples of their waters to be analyzed.

No change appears to have taken place in the conditions about the Hygeia Spring, and the results of an analysis of a sample of water show that its condition remains about the same as at the time of the previous examination last year. The water entering this source has at some time been considerably polluted and subsequently well purified in its passage through the ground, and in its present condition is probably safe for drinking.

The water of the Massasoit Spring is also found to be of about the same

quality as at the time the previous examination was made. The conditions about this spring remain the same as at the time of the previous examination, and this source continues to be exposed to danger of pollution by visitors, as in former years.

The water of the Iroquois Spring shows, upon analysis, an improvement in many respects over its condition at previous times, and the conditions about the spring have also been materially improved by the construction of a building to prevent access to the spring by visitors.

The water of the Wilbraham Mountain Spring has slightly improved since the previous analysis was made, but the conditions about the spring remain the same as at the time of the previous examination. It is desirable that the present method of collecting water from the spring be changed, and that the spring be covered and all water drawn by means of a pump or pipe, so arranged that the waste water or water polluted in handling may not flow back into the spring.

The Board would call attention to the fact that spring waters are in many cases contaminated in the process of collection and delivery to consumers, and that it is important that danger of contamination from these causes should be guarded against.

STOCKBRIDGE.

MARCH 3, 1904.

To ARTHUR LAWRENCE, D.D., and others, *Stockbridge, Mass.*

GENTLEMEN: — In response to your request for an examination by this Board of the condition of the water supply of the town of Stockbridge, and information as to methods by which the quality of the water can be improved, the Board has caused Lake Averic, the source of supply, to be examined by one of its engineers, and has examined the results of many analyses of this water made within the past few years.

The water-shed of Lake Averic is uninhabited, and the source is free from danger of sewage pollution. The water has generally but little color, and the quantity of organic matter present in the water, as shown by the analyses, is not excessive for a surface water. The results of the examinations show that the water supplied to the town is frequently affected by the presence of *Uroglena* and other organisms of kinds which impart to water an offensive taste and odor, rendering it objectionable for drinking and other uses, and it is probable that the objectionable quality of the water supplied to Stockbridge is due chiefly to the presence of such organisms.

The microscopic organisms and the disagreeable tastes and odors could be removed from this water by filtration through sand, at no great difficulty or expense; and this is the best practicable plan, in the opinion of the Board, of improving the quality of the water supply of the town of Stockbridge. The head available between the pond and the pumping sta-

tion is ample to allow for filtration of the water; and if sand filters 5 feet in depth, having an area of about one-tenth of an acre, should be constructed in this neighborhood, all of the water supplied to the town could be filtered and rendered satisfactory at all times, and the Board would advise the adoption of this method for the purification of the water supply of Stockbridge. The filters should be designed and constructed under the direction of an engineer of experience in the construction of such works.

UXBRIDGE.

JULY 7, 1904.

To the Water Committee of the Town of Uxbridge.

GENTLEMEN: — The State Board of Health received from you on May 24 an application for advice with reference to an additional water supply for the town of Uxbridge, in which your proposed plan is described as follows: —

> The town of Uxbridge proposes to increase its water supply by the addition of ground water from the valleys of Crony and Cold Spring brooks and well on Douglas Street, — all of the above, or either of them.

Subsequently tests were made in the valley of Crony and Cold Spring brooks and in the valley of Williams Hill Brook, a tributary of Cold Spring Brook, to determine the practicability of obtaining a ground-water supply in either of these valleys. Samples of water from the test wells were collected and sent in by you while the tests were in progress.

The Board has caused these samples of water to be analyzed and an examination of the localities indicated by you to be made by one of its engineers, and has considered the available information as to the proposed sources of supply.

The samples of water sent in by you are of little value in determining the probable quality of the water obtainable in the regions indicated, on account of the large quantity of sand and dirt collected with the samples. The results of the tests as a whole show, however, that it is improbable that any considerable quantity of water can be obtained from the ground in the valley of Crony Brook or in the valley of Williams Hill Brook; and, while the tests in the valley of Cold Spring Brook indicated that the conditions existing there are less unfavorable than in the other places, it is very doubtful whether it is practicable to obtain in this valley enough water for the supply of Uxbridge at reasonable expense.

Examinations made by the Board show that there are places in Uxbridge in which the conditions are much more favorable, judging from surface indications, for obtaining water freely from the ground, than in the localities in which your tests have been made. Under the circumstances, the Board does not approve the sources of water supply proposed in your application.

An adequate public water supply is greatly needed by the town, and the Board would urge that investigations be made without delay in those places where the conditions appear favorable for obtaining an adequate water supply.

OCT. 6, 1904.

To the Water Committee of the Town of Uxbridge, Mr. JAMES DALEY, *Chairman.*

GENTLEMEN: — The State Board of Health, in accordance with your application of Sept. 16, 1904, for advice as to taking water for the supply of Uxbridge from the ground near the West River, a short distance above the mouth of Meadow Brook, has caused the locality to be examined by one of its engineers and a sample of water collected from a test well driven in this locality to be analyzed.

The water was found upon analysis to be of excellent quality for the purposes of a public water supply. It is impracticable to determine, however, from a test like this, whether the quality of the water would remain satisfactory if water should be drawn from the ground in such quantity as would be necessary for the supply of Uxbridge.

Regarding the quantity of water that can be obtained from the ground at this place, it is not practicable to form a definite opinion from the information now available. The soil in this neighborhood appears to be coarse and porous to a considerable depth, and the test well yielded water freely when pumping with a hand pump, — indications which are favorable for obtaining water from the ground in considerable quantity.

The Board would advise, as the next step in your investigation, that you proceed to make further tests to determine the probable quantity and quality of water to be obtained from the ground at this place, by sinking several wells, connecting them together and pumping from them with a steam pump for a period of at least a week, and at a rate as great as will be necessary for the supply of Uxbridge. It is essential that a further test be made before it will be practicable to determine whether the source is an appropriate one for the water supply of Uxbridge. The Board will assist you in making the test, if you so request, by making the necessary analyses of water from the wells. The present is a favorable season for such tests, and it is desirable that the test be begun without unnecessary delay.

JAN. 5, 1905.

To the Water Supply Committee of the Town of Uxbridge, Mr. ARTHUR R. TAFT, *Clerk.*

GENTLEMEN: — The State Board of Health has considered your communications of December 15 and 29, for advice relative to taking a water supply for the town of Uxbridge from the ground in the valley of Mendon Pond Brook, near its confluence with the West River, and has examined the results of your recent investigations in this locality and the analyses of samples of water collected daily between December 6 and December 15, during a pumping test, from a group of tubular wells located near the

northerly bank of Mendon Pond Brook, and about 500 feet from the West River.

The pumping test was made in a dry period, but a quantity of water ample for the present requirements of Uxbridge was obtained from the temporary works without difficulty and without material lowering of the ground water, indicating that a sufficient quantity of water for the town can be obtained from the ground in this region.

The results of the analyses of water collected during the test show that it was at all times clear, colorless and odorless, and otherwise of good quality for the purposes of a public water supply. The region about the wells is very sparsely populated, and if the town should secure control of a considerable area of land about the wells, and prevent its cultivation and the building of dwelling houses there, the quality of the water can be protected, and this source will, in the opinion of the Board, be a satisfactory one for the town of Uxbridge.

Ground waters, such as the water of these wells, deteriorate rapidly when exposed to light; and it is important, if this source of supply shall be used, that the water be stored in a covered reservoir and kept from exposure to light.

Wakefield.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on Oct. 6, 1904, for preventing the pollution and securing the sanitary protection of the waters of Crystal Lake and its tributaries, used by the town of Wakefield as a source of water supply.

Waltham.

March 3, 1904.

To Hon. Murray D. Clement, *Mayor, Waltham, Mass.*

Dear Sir: — The State Board of Health has considered the application of the mayor of Waltham, received in the latter part of last year, for advice as to the future water supply of the city, as stated in the following communication: —

> The city of Waltham has now under consideration plans for a covered reservoir for maintaining the quality of the water, also plans for increasing the supply, as outlined in the last report of the water department. Some metering has been done.
>
> The advice of the State Board is asked as to whether the supply can be maintained in its present purity and in satisfactory quantity for a period of time sufficient to justify this large expenditure on our works, in view of the probable cost to the city of entering the sytem and taking water from the metropolitan works.

In response to this application, the Board has considered the results of analyses and other information now available as to the present condition of your water supply, and has considered the plans for increasing the supply

as outlined in the report of the water department, and other possible plans for enlarging the water supply of the city.

The water of the present filter-gallery, after being covered some twelve years ago, so as to exclude the light, was for several years generally clear, odorless and nearly colorless, and changed very little in character from month to month. In more recent years its quality has deteriorated; and in a communication to the water works authorities of the city, dated July 3, 1902, the Board advised as follows as to possible remedies: —

The results of analyses of water from the well have shown for several years that the water passing through the ground into the well is being polluted; and there has been a deterioration in the quality of the water drawn from the well, owing to an increase in the quantity of iron, though the quantity of iron present in the water has not yet become so great as to noticeably affect its quality. The increase in the quantity of iron is doubtless due to the passage of imperfectly filtered water into the well from Charles River, and in part to pollution of the ground waters tributary to the well.

In a commuuication to the mayor of Waltham in 1897 the Board suggested, as possible remedies for the deterioration in the water, that all sewage be removed from the territory supplying water to the filter basin; that the draft from the basin be diminished so that it should not exceed the amount drawn from the basin before the quantity of iron began to increase; and that another source be secured for the additional water required for the city.

It does not appear that sewers have yet been extended into the territory near the wells which required sewerage at that time, though plans for the sewerage of this territory have now been prepared. The quantity of water used by the city in 1901, moreover, was 50 per cent. greater than in 1897, and more than twice as great as at the time the quantity of iron in the water began to increase. Under the circumstances, it is likely that the quality of the water will continue to deteriorate.

If the quality of the water should continue to deteriorate and the quantity of iron increase at as great a rate as in the past few years, the water would soon become objectionable for many domestic purposes, and a supply of water from some other source become necessary.

The offensive taste and odor of this water, frequently complained of in past years, has been due, since the covering of the filter-gallery, to the presence of microscopic organisms in the water of the open distributing reservoir, and it has been known for many years that trouble from this cause could be prevented by covering the reservoir; but a covered reservoir would have no effect in preventing consequences of deterioration due to the presence of an excessive quantity of iron in the water, and such a reservoir would be of no material value if a water supply should be introduced hereafter from surface sources, such as those used by the metropolitan district referred to in the application. It is essential to decide, if possible, as to the source from which the future supply is to be obtained, before making changes at the reservoir.

As to possible sources of supply, reference is made in the application to the metropolitan water district and to the plan of obtaining a supply from the ground near the river above your present works.

If a supply of good water, ample, in connection with the present source, for the requirements of the city for a considerable period of years, could be obtained from the ground near the river above the present filter-gallery, and if the quality of the water of the latter source should materially improve, as a result of a greatly decreased draft from this source, it would then be practicable for the city, by building a covered reservoir, to secure a supply of good water, free from the objectionable conditions now complained of, and at less expense than by joining the metropolitan district.

The examinations made with reference to securing an additional water supply, as described in the annual report of the water board, referred to in the application, consisted in sinking several test wells in the neighborhood of the river, from 600 to 1,400 feet up stream from the present filter-gallery, the tests indicating that the soil in this neighborhood was coarse and porous to a considerable depth. Observations upon the height of the water in these wells, however, showed that in all cases the water was lower than the level of the water of the river, indicating clearly that the ground water at the places at which these wells are located is already influenced by the pumping from the present filter-gallery.

In order to secure a very large additional supply from the ground near the Charles River, and at the same time reduce the rate of filtration through the ground in the area affected by pumping from your present filter-gallery, it will be necessary to locate the new wells or other sources of additional supply beyond the area materially affected by pumping from the present source.

The soil near the river above the present filter-gallery consists apparently of coarse and porous gravel for a long distance up stream; and it seems probable that wells could be located at some point in this region beyond the area influenced by pumping from your present filter-gallery, from which water can be drawn in large quantities.

The region about the river above your present filter-gallery within the limits of the city and on the opposite side of the river in Newton is, however, becoming somewhat thickly populated, and the river is also considerably polluted at points above Waltham. The stream and its banks are now used also as a pleasure resort by large numbers of people, and it may be impracticable to secure ground water of good quality in this region. If this should be found to be the case, there are two other possible methods by which a supply of water might be obtained: one by drawing water from Stony Brook (the right to a supply from this source having been reserved to the city of Waltham in the legislation of 1884); and the other by filtering the water of the Charles River.

The water of the Charles River, from the stand-point of its use as a

source of public water supply, is considerably polluted, as already indicated, and its waters would be unsafe for drinking unless thoroughly purified by filtration. By proper filtration the water could undoubtedly be made safe for drinking; but it is not desirable, in the opinion of the Board, to resort to this plan of securing a water supply, if it is practicable to secure a supply from sources which are protected from sewage pollution.

Stony Brook would furnish an ample supply of water for the city of Waltham for a long time in the future; and, inasmuch as the city has a right to a supply from this source, it is important to consider the possible advantages of using it, as compared with other available sources. In the consideration of this source, it is necessary to take into account the probability of a considerable increase in the population on the water-shed, and the possible necessity of filtering the water at some future time. The Board is unable to advise you as to the probable cost of a supply from this source, but it seems likely that the cost will be less than the cost of taking a supply from the metropolitan district.

Considering all the circumstances, the Board would advise the city of Waltham to make investigations as to the practicability of obtaining an auxiliary supply of water from the ground in the neighborhood of Charles River, beyond the area influenced by pumping from the present filter-gallery; and, if it is found practicable to obtain a satisfactory auxiliary supply in this way, that an estimate be made of the probable cost of works for supplying the city by this plan, including the cost of a covered reservoir.

Tests of the ground in the neighborhood of Charles River should be made in a thorough manner, and should include an adequate pumping test, to determine the probable quantity and quality of water obtainable. At the same time, information should be collected as to the probable cost of a supply both from Stony Brook and from the metropolitan water district, having in view the present needs of the city and its probable future requirements for several years. The Board will assist you in these investigations, if you desire, by making the necessary analyses of water, and will give you further advice in the matter when the results of further investigations are available.

WALTHAM (ALDEN CLARK).

OCT. 6, 1904.

TO MR. ALDEN CLARK, *Waltham, Mass.*

DEAR SIR: — In accordance with your request of August 24 for an examination of a spring located in the valley of Beaver Brook, near the corner of Bacon and Lexington streets in Waltham, from which you state that you propose to sell water for drinking, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The water-shed of the spring is uninhabited, and the results of the analysis of the water show that it is of good quality for drinking.

Under present conditions, this spring may, in the opinion of the Board, be used with safety as a source of drinking water supply, provided suitable precautions are used to prevent the entrance of surface water or the pollution of the water of the spring in collecting and distributing it to consumers.

Wellesley (Wellesley College).

July 11, 1904.

To Miss Caroline Hazard, *President, Wellesley College, Wellesley, Mass.*

Dear Madam: — The State Board of Health has considered your request for advice as to the quality of the water of certain tubular wells recently driven on the grounds of the college in Wellesley, and has caused the wells and their surroundings to be examined and samples of their waters to be analyzed.

The results of the examination show that the water of these wells is at the present time of good quality for drinking. An analysis of a sample of the water of the wells put in in the latter part of last year shows that the quality of this water has deteriorated slightly, as compared with the analyses made in October of last year.

Both groups of wells are located within a short distance of the area formerly used for sewage disposal, and sewage has been discharged into the ground at other places in the neighborhood. With these conditions the water of both groups of tubular wells is liable to deteriorate and become unsafe for drinking, if a large quantity of water, such as would be required for the supply of the college, should be drawn from them continuously.

It appears that water from one of these groups of wells is now used for mechanical and certain other purposes in the college buildings; and the Board would recommend that, before using this water for drinking, tests be made from time to time, to determine what changes, if any, take place in its quality while it is being used as at present; and the Board will, upon request, make the necessary analyses, if you will have the samples collected.

If it is not deemed desirable to continue the use of water from these wells for any purpose until its probable quality is known more definitely, the Board would recommend that a pumping test be made by pumping from the wells continuously for a period of two weeks at a rate as great or greater than that at which the water would be drawn if the wells were used as a source of water supply for the college; and that samples be collected during the test, to observe what changes, if any, take place in the quality of the water. The Board will, in this case also, upon application, make the necessary analyses of the water, and in either case will give you further advice as to the quality of the water of these wells when the results of further tests are available.

Oct. 6, 1904.

To Miss Caroline Hazard, *President, Wellesley College, Wellesley, Mass.*

Dear Madam: — Your communication of September 28, requesting further advice as to taking water from a system of tubular wells on the college

grounds for the supply of the college, has been received and considered by the State Board of Health.

It appears that, since the communication of the Board made in July last, recommending a further test of the practicability of obtaining a good water from wells near the power house in the northerly part of the college grounds, you have caused additional wells to be put in there, and a pumping test to be made by pumping from eight wells for a period of about ten days, from August 12 to 22, at a rate of about 350,000 gallons per day; and samples of the water of the wells, collected and sent in by you from time to time during the test, have been analyzed by direction of the Board.

The wells are located in a region having porous soil over a large area, which extends to a depth of nearly 70 feet at the wells. These conditions, taken in connection with the large quantity of water pumped from the wells during the test, indicate that a sufficient supply for the college could probably be obtained from the ground at this place.

The results of the analyses of the samples of water show that it remained practically constant in quality throughout the test, being clear, colorless and free from odor, and in other respects of good quality for water supply purposes.

The quality of the water showed no tendency to deteriorate during the pumping test, but there are possible sources of pollution which may in time affect the quality of the water; and it is important, in the opinion of the Board, that, if water from these wells be used for the supply of the college, it be analyzed from time to time, in order that any deterioration may be detected. The Board will make the necessary analyses, if you will have the samples collected and sent to its laboratory.

WESTFORD.

FEB. 4, 1904.

To the Board of Selectmen of the Town of Westford.

GENTLEMEN: — The State Board of Health has considered your application for advice with reference to a proposed water supply for the town of Westford, to be taken from the ground in the neighborhood of the Westford station on the Nashua, Acton & Boston Railroad, so called, and has caused the locality in which it is proposed to obtain the supply to be examined by its engineer.

The conditions in the neighborhood of the station, and especially north of the highway leading from Forge Village to Westford west of the railroad, appear to be favorable, judging from surface indications, for obtaining good water freely from the ground by means of wells, and the locality is favorably situated for supplying water to the three main villages in Westford without special difficulty.

The Board would advise, as the next step in the investigation, that you cause tests of the ground in this region to be made, by means of wells, to

determine the character of the soil and the probable quantity of water to be obtained, and that you cause samples of the water from test wells to be analyzed to determine its quality. These tests should be made under the direction of an engineer of experience in matters relating to water supply, and the Board will assist by making the necessary analyses of samples of water, and will give you further advice in the matter when the results of the tests are available.

The Board has also, in accordance with your request, examined a considerable number of private wells in Westford and Graniteville, and caused samples of their waters to be analyzed. Nearly all of these wells show evidence of serious pollution by sewage, and in many cases it is not practicable for those dependent upon them to secure water of better quality upon their own premises.

A public water supply, aside from its other advantages, is greatly needed in these villages to make it practicable to discontinue the use of polluted waters for domestic purposes.

WESTON (CEMETERY NEAR SOURCE OF WATER SUPPLY OF CAMBRIDGE).

APRIL 28, 1904.

To the Board of Selectmen of the Town of Weston, MR. FRANCIS BLAKE, *Chairman.*

GENTLEMEN: — The State Board of Health has considered your application of March 31, for the approval of the use for cemetery purposes of certain land in Weston lying south of and adjacent to Linwood Cemetery, shown upon a plan submitted with your application, and has examined this land. With the exception of a low area at the south-easterly corner, the land is dry, and unlikely, in the opinion of the Board, to cause pollution of adjacent waters if used for the purpose indicated.

The Board hereby approves the use for cemetery purposes of the land south of Linwood Cemetery, marked "Proposed Addition, 8.91 Acres," as shown upon a plan entitled "Linwood Cemetery, Weston, Surveyed by John N. McClintock, C.E. Scale, $1'' = 200'$," and filed in the office of this Board April 6, 1904, provided that no interment shall be made in any portion of the area within 200 feet of the south-easterly corner thereof, as shown on the above-described plan.

WEST SPRINGFIELD.

JAN. 5, 1905.

To the Board of Water Commissioners of the Town of West Springfield, MR. C. M. WOODWARD, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on September 26 the following communication: —

The town of West Springfield, being for several years in need of an additional water supply, and having investigated the several possible schemes for obtaining such supply, has settled upon the source known as the Bear Hole Brook, and the

water-shed contributory thereto, lying within the limits of said town, except a small portion in the adjoining city of Holyoke. Options have been obtained on a large part of the land needed for full future development, engineering features worked out, funds voted by the town for the work at present contemplated, and preparations are well along for carrying it out. We would ask of your Board advice in the matter of development of the supply, and putting it into thoroughly good shape for the town's use. We desire to know the proper means of securing the purity of the water, the extent of ground necessary to control to prevent contamination, our rights as against public carelessness leading to contamination, and to receive such general information as you can give us bearing on the work. We would propose to develop the system slowly, as the needs of the town require, but to do the work in hand thoroughly and systematically.

The plan for developing a water supply from Bear Hole Brook, prepared by your engineers in 1899, provided for the construction of a storage reservoir holding about 311,000,000 gallons upon this stream, by constructing a dam about a mile below Bear Hole Spring, so called.

The plan which you now propose to adopt, and which you have described further to the engineer of the Board, provides for the construction at the present time of a pumping station near the brook, in the neighborhood of the proposed dam, and for a pipe line through which the water is to be forced to a new stand-pipe, which you are now preparing to construct upon a hill about one and one-half miles north-west of the village.

The Board has caused a further examination of the locality to be made by one of its engineers, and has considered the results of investigations relative to obtaining a water supply for the town.

Bear Hole Brook forms the outlet to Ashley Pond, one of the sources of water supply of the city of Holyoke; and when the pond is full, or nearly so, a large quantity of water leaks from the pond into the brook below the dam. The soil of part of the drainage area of the brook above the proposed point of taking is coarse and porous, especially on the easterly side, so that the flow is maintained in dry weather. Under ordinary conditions it is probable, in the opinion of the Board, that a sufficient additional water supply for the present needs of West Springfield could be obtained from this source without storage, but in a very dry season the yield of the stream might prove inadequate for the requirements of the town.

The water-shed of Bear Hole Brook is sparsely populated, but there is a picnic ground a short distance above the proposed point of taking, and there are dwelling houses and other buildings on the stream farther up the valley. In order to protect adequately the purity of the water of the stream, it would be necessary to purchase and remove many of the dwelling houses and buildings now within the water-shed, the cost of which, judging from the information furnished by you, would be large; and it would also be necessary, in order to secure protection in the future, to control a considerable area of land within the water-shed.

Considering the circumstances, the Board does not deem it advisable for West Springfield to take water directly from Bear Hole Brook, as now proposed. It appears to be possible to obtain a considerable quantity of water from the water-shed of Bear Hole Brook by means of wells or filter-galleries sunk in the valley of the brook, at places where land could be secured at reasonable cost, and thus avoid the large expense for lands, buildings, etc., which would be necessary under the plan now proposed; but no tests have been made in the valley which would show whether such a plan for securing a water supply for West Springfield would be practicable, or not. The town is growing rapidly, and, while a quantity of ground water might be obtained in this valley by means of wells or filter-galleries, which would be sufficient for present requirements if used in connection with existing works, it will be necessary, if the growth of the town continues, to secure a further supply. The plans for developing a large supply from Bear Hole Brook, proposed by the engineers who investigated the question of a water supply for West Springfield five years ago, provided for the construction of a storage reservoir upon this stream, holding a little over 300,000,000 gallons; and there is no doubt that with such a reservoir an ample supply of water for the requirements of West Springfield could be made available. The reservoir, however, would be supplied in part with ground water, which would be liable to deteriorate greatly in the storage reservoir, and become objectionable on account of organic growths and the offensive tastes and odors which they produce.

The Board has advised you on previous occasions, when considering the future water supply of West Springfield, to examine the practicability of obtaining a ground-water supply from the neighborhood of Pond Brook, near the Holyoke and Westfield Railroad, but it does not appear that any studies of this locality have been made. The Board would again advise that the question of water supply from the valley of Pond Brook be given careful consideration, before the town proceeds to develop a supply from the valley of Bear Hole Brook; since it seems likely, from the investigations that have been made by the Board, that an adequate supply of excellent water can be obtained from the valley of Pond Brook at no greater, and very likely at less, expense than from Bear Hole Brook, and that a water of much better quality could be secured.

Investigations might at the same time be made of the practicability of obtaining a ground-water supply in the valley of Bear Hole Brook sufficient for the present requirements of the town; and if it should be found practicable to obtain a considerable supply of good water from the ground in this valley, there might be economy in the use of this source for a time, rather than to go to Pond Brook in the beginning.

In case you decide to make further investigations in the valley of Pond Brook or in the valley of Bear Hole Brook, with a view to obtaining a

ground-water supply, the Board will, upon request, make the necessary analyses of water, and will give you further advice when the results of further investigations are available.

Woburn (W. W. Cummings).

Nov. 3, 1904.

To Mr. W. W. Cummings, *Boston, Mass.*

Dear Sir: — In response to your request for advice as to the quality of the water of certain springs at Woburn, from which you propose to sell water for drinking purposes, the Board has caused the springs and their surroundings to be examined and samples of their waters to be analyzed.

The results of the analysis of the water of the spring near 15 Winter Street show that the water is probably safe for drinking at the present time; but the spring is located beside a brook, the water of which is exposed to pollution from buildings on its water-shed, and at times of high water the brook water can evidently find its way into the spring, and, in the opinion of the Board, this spring is not, under the circumstances, a safe source of drinking water.

The water of the spring farther north, near the old mill pond near Winter Street, contained, when examined, a much greater quantity of organic matter and a larger number of bacteria than are found in good spring waters. These conditions may possibly have been due in part at least to the fact that the spring is uncovered, and that surface water can enter it. The spring cannot in its present condition be regarded as a safe source from which to take water for drinking. It is possible that the water of this spring might safely be used for drinking if the spring were cleaned and covered so as to exclude surface water.

Worcester.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board, on April 7, 1904, for preventing the pollution and securing the sanitary protection of the sources of water supply of the city of Worcester.

Wrentham.

April 7, 1904.

To the Committee on Water Supply of the Town of Wrentham, Mr. William F. Maintien, *Chairman.*

Gentlemen: — The State Board of Health has considered your application received March 8, 1904, for advice with reference to a proposed water supply for the town of Wrentham, and the plans and report submitted therewith, which provide for taking water either from tubular wells and springs near the Trout Ponds, or from tubular or other wells near Archer's

Pond, and has caused the localities to be examined and two samples of water collected from tubular wells at these places and sent in by you to be analyzed.

The results of the analyses show that the water of the test wells at both places is of good quality for the purposes of a public water supply, the water of the tubular well near the Trout Ponds being a little the better of the two.

It does not appear that there is likely to be a very material difference in the cost of a supply from either the Trout Ponds or Archer's Pond sources, but a supply from the former source seems likely, from the estimates presented, to cost a little less than a supply from the latter source.

The superficial area of the water-shed of the Trout Ponds, as shown upon a plan submitted with your application, is stated to be 45.4 acres, but additional areas are indicated that may be tributary to this source. Measurements of the flow of water from the lower pond of the group, made last July, show that the flow from these ponds at that time amounted to about 150,000 gallons per day. In a very dry season it is probable that the flow would be less than this amount; and these circumstances indicate that it is somewhat doubtful whether a sufficient quantity of water for the supply of Wrentham, after water has come into general use in the town, can be obtained from wells in this neighborhood.

The results of the tests and investigations thus far made are, on the whole, favorable to obtaining an ample supply of water for Wrentham from the region near Archer's Pond; but before taking a supply from either source it is necessary, in the opinion of the Board, to make further tests, to determine more definitely the probable quantity and quality of water that the sources are likely to yield.

Since water of somewhat better quality can apparently be obtained in the neighborhood of the Trout Ponds, and probably at a somewhat smaller cost than from the neighborhood of Archer's Pond, the Board would advise that tests be made first of the soil about the Trout Ponds by means of tubular wells, and that tests should also be made in the valley of the stream below the lower pond. If these tests show that porous soil extends to a considerable depth and that water can be obtained freely from the ground by means of wells, a pumping test should be made, and the effect of the pumping upon the level of the ground water and the flow of the water of the ponds carefully noted. When the results of suitable tests and observations are available, it will be practicable to determine whether this source is likely to yield a sufficient quantity of water for the supply of the town. The cost of such a test would be inconsiderable, as compared with the cost of changing the source after the works have approached completion or subsequently, as would be necessary if it should be found that the supply was inadequate.

If, as a result of further tests at the Trout Ponds, that source should not be deemed appropriate for the use of Wrentham, further tests should then be made in the neighborhood of Archer's Pond.

The Board will assist you in such investigations of the proposed sources as you may decide to make, by making the necessary analyses of water, and will give you further advice when the results of further tests are available.

Ice Supplies.

The following is the substance of the action of the Board during 1904 in reply to applications for advice relative to sources of ice supply: —

Chicopee.

Jan. 5, 1905.

To the Board of Health of the City of Chicopee.

Gentlemen: — In response to your request for advice as to the use, as a source of ice supply, of a reservoir to be constructed upon the stream which crosses the Rockrimmon Road, about 300 feet north of Plainfield Street, in the extreme southerly part of Chicopee known as Glenwood, the Board has caused the locality to be examined and a sample of the water of the stream to be analyzed.

The results of the examination show that there is a large cemetery within the water-shed of the stream, and there is also apparently a considerable number of dwelling houses within this water-shed near its upper end. An analysis of a sample of the water shows that the stream receives considerable pollution at the present time, and is not a desirable source of ice supply.

It is possible that ice which might safely be used for domestic purposes could be obtained from a reservoir on this stream by removing from the ice, when harvesting, the first inch which formed upon the pond and all ice formed above this first inch, including snow ice and ice formed by flooding, and by rejecting all ice containing particles of foreign matter.

It is important, in constructing a reservoir for use as a source of ice supply upon this stream, that the reservoir be made of sufficient size so that there will not be a rapid current of water through the pond.

Everett.

Aug. 4, 1904.

To the Board of Health of the City of Everett.

Gentlemen: — The State Board of Health received from you on July 16, 1904, a request for an examination of the following sources, from which ice is taken for sale in Everett: Pentucket Lake, in Georgetown; Crystal Lake, in Wakefield; Bennett's Pond, in Melrose; Crystal Lake, in Melrose; Towner's Pond, in Melrose; Long Pond, in Melrose and Saugus; Swain's Pond, in Melrose.

Subsequently the request for advice as to the use of Crystal Lake, in Wakefield, as a source of ice supply, was withdrawn.

The Board has caused the various lakes and ponds mentioned in your application to be examined, and samples of their waters, and of the ice harvested from them in all cases where samples were obtainable, to be analyzed.

With the exception of Pentucket Lake, in Georgetown, all of the sources mentioned in your application were examined by the Board in 1901, in response to a request from the city of Melrose for advice as to the use of these lakes and ponds as sources of ice supply; and the Board advised the authorities of that city as follows concerning the use of ice from Crystal Lake, in Melrose (otherwise known as Ell Pond), Bennett's, Long, Swain's and Towner's ponds, the latter being known at that time as Dorr's Pond: —

In response to your request for advice as to the quality of the ice of Ell Pond, Bennett's Pond, Long Pond, Stillman's Pond and Swain's Pond, in Melrose, the Board has caused the various sources of ice supply in Melrose which have been brought to its attention to be examined, and samples of the water and ice to be analyzed.

Ell Pond is situated in the central portion of Melrose, and receives the drainage from a territory containing a dense population, and is evidently considerably polluted by sewage.

Numerous samples of ice collected from various parts of this pond, both during the winter just passed and the previous winter, have been analyzed by the Board; and, judging from the results of all its examinations, the Board is of the opinion that the ice of Ell Pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used.

Under the existing conditions, the only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond, and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

The Board would advise that no ice be cut in the immediate neighborhood of the feeders of the pond, the flow from which may cause matters to become entangled in the ice, or at any place in the pond where the water is shallow, and there would be danger that weeds or organic matters from the bottom of the pond might be taken up by the ice.

All of the other sources examined show evidences of sewage pollution, and the Board is of the opinion that the only safety in using ice from these sources also, excepting Dorr's Pond, is to provide that the harvesting of the ice shall be done under your direction and control, and that the ice be inspected in the same manner as recommended in the case of Ell Pond; that is, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond, and all of the ice which forms above the first inch, and to insure the rejection of all ice containing particles of foreign matter.

Some of these ponds are quite shallow, or contain large areas where the depth of the water is small. The Board would call special attention to the liability, in

shallow ponds and in all ponds if ice is cut near the shore, that weeds, grass or other foreign matter may be frozen into the ice, which would render it entirely unfit for domestic uses. This was the case with the ice examined from Dorr's Pond, and the Board would advise that the ice from this source be not used where it will come in contact with food or drinking water.

The recent examination of these sources shows that no material change has taken place in the condition of the various ponds or their surroundings; and, in the opinion of the Board, ice taken from these sources can be used with safety only by observing carefully the precautions advised in the communication quoted above. The sample of ice collected recently from Towner's Pond, formerly known as Dorr's Pond, did not differ materially in quality from the others.

Ice collected from Pentucket Lake, in Georgetown, may, in the opinion of the Board, be used with safety for domestic purposes..

FALMOUTH.

JULY 7, 1904.

To the Board of Health of the Town of Falmouth, MR. RUSSELL S. NYE, *Secretary*.

GENTLEMEN: — In accordance with your request of June 15, the State Board of Health has caused an examination to be made of Shivericks Pond and its surroundings, and has caused samples of the water of the pond and of the ice found in the ice house located at the westerly end of the pond to be analyzed.

The pond is located near the village, and an analysis of the water indicates that it contains considerable organic matter, but there is no evidence that this is derived from sewage pollution. A sample of the ice collected from one of the ice houses was found to consist of about 10 inches of clear ice, with a thin layer of snow ice on top. The clear ice was free from foreign matter, and was found, upon analysis, to be of good quality.

In the opinion of the Board, this ice may safely be used for domestic purposes, but the snow ice is liable to contain impurities, and should be rejected.

HARDWICK (WHEELWRIGHT).

SEPT. 1, 1904.

To the Board of Health of the Town of Hardwick, MR. CHARLES F. ANGELL, *Agent*.

GENTLEMEN: — Your communication of August 5, enclosing a letter of the Winimissett Ice Company of Hardwick, relative to the pollution of the Ware River above the village of Wheelwright, has been considered by the State Board of Health.

It appears that the water of the river is used as a source of water supply by the George W. Wheelwright Paper Company, but the letter from that corporation to your board states that the paper company has advised the persons who take water from its pipes not to use any of it unless it has been boiled. The stream receives much pollution from mills and

villages above Hardwick, and is not a suitable source of drinking water supply, and should not be so used.

A sample of ice said to have been harvested from the river last winter was found to contain but little organic matter, and was in other respects of good quality, indicating that at the time this ice was harvested it was possible to obtain from this source ice which might safely be used for domestic purposes.

While the conditions remain as at the time this ice was formed, it is possible to obtain from this source ice which may safely be used for domestic purposes; but ice from such a source can only be used with safety by removing the first inch which forms upon the pond, and all ice formed above this first inch, whether by snow or rain or flooding, and rejecting all ice containing particles of foreign matter.

The State Board of Health, under the provisions of section 118 of chapter 75 of the Revised Laws, is authorized, under certain circumstances, to take action for the prevention of the pollution of an ice supply; but, in the opinion of the Board, it would be impracticable to prevent the pollution of this stream under that law, unless at great expense to the ice company.

Holyoke.

Aug. 4, 1904.

To the Board of Health of the City of Holyoke.

Gentlemen: — In response to your application for an examination of two ice ponds in Holyoke, and advice as to their use as sources of ice supply for domestic purposes, the Board has caused the ponds and their surroundings to be examined and samples of the water and ice to be analyzed.

One of the ponds, known as Bray's Pond, is located south of Westfield Road and west of Northampton Street in Holyoke. The water of this source was found to contain a very large quantity of organic matter, but the quantity of organic matter found in a sample of the ice was small. In response to a previous application for advice as to the use of this pond as a source of ice supply, the Board advised you as follows: —

Bray's Pond, located south of the Westfield Road and west of Northampton Street, evidently receives considerable polluting drainage, and the effect of this pollution is evident in the analysis of a sample of the water. The ice cut from this pond was found to contain a larger amount of organic matter than is usually present in ice from unpolluted sources, and this pond in its present state cannot be considered a safe source from which to take ice for use in connection with food or drinking water. It appears to be practicable to prevent the pollution of this source by diverting the drainage from the limited number of buildings on the water-shed away from the pond.

It appears from the recent examination that the conditions are somewhat worse than at the time the previous examination was made. It would

apparently be practicable, at small expense, to divert away from the pond the drainage from the buildings mentioned; and if this should be done, the ice from this source might, in the opinion of the Board, safely be used for domestic purposes.

The other pond is located near Jarvis Avenue, in Holyoke, not far from Cherry Street. This source has already been examined by the Board, in response to an application from you on Dec. 18, 1900, for advice as to its use as a source of water supply; and the Board advised you, on Jan. 21, 1901, as follows:—

In response to your application of Dec. 18, 1900, for advice as to whether the water of the stream known as Crystal Spring, used to supply about five hundred residents of the district known as Elmwood, in Holyoke, is suitable for domestic use, the Board has caused the source to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water at the present time, while somewhat hard, is nearly colorless, and contains but little organic matter. An examination of the water-shed shows that near its upper end there are two dwelling houses and a building which has been used in the past as a small-pox hospital for the city of Holyoke; but for several years no cases have been treated at this place, though the building is maintained ready for use. It does not appear that polluting matters are entering directly any of the streams in the water-shed at the present time, and, in the opinion of the Board, the water at present is suitable for domestic use.

It is exposed, however, to possible danger of serious pollution from the buildings on the water-shed; and if the use of the source is to be continued, it will be necessary to see that all polluting matters from any of these buildings or from any of the farming operations within the water-shed are kept out of the streams at all times; and especial care should be taken, in case any contagious or infectious disease should appear on this water-shed, to prevent danger to the water supply therefrom.

An analysis of a sample of ice collected recently from this pond shows that it contains considerable organic matter; but, in the opinion of the Board, this pond may safely be used as a source of ice supply for domestic purposes, if polluting matters from the buildings on the water-shed are kept out of the pond.

LITTLETON.

JULY 7, 1904.

To the Board of Health of the Town of Littleton, Mr. J. N. MURRAY, *Secretary.*

GENTLEMEN:—In response to your request, received May 24, for advice as to the use of ice for domestic purposes taken from Mill Pond, so called, in Littleton, the Board has caused the pond and its surroundings to be examined, and has caused a sample of the ice from an ice house located near the northerly end of the pond, from which, the Board is informed, ice is supplied for domestic purposes in Littleton, to be analyzed.

The results of the examination show that the ice, as harvested, contained a thin layer of snow ice at the top, but that otherwise the ice was clear and apparently free from foreign matter. The chemical and bacterial analyses show that the clear ice contains very little organic matter or bacteria; and, in the opinion of the Board, the clear ice may safely be used for domestic purposes. The snow ice should be completely removed before using.

Milton.

April 7, 1904.

To the Board of Health of the Town of Milton.

Gentlemen: — The State Board of Health received from you on Feb. 17, 1904, an application requesting an examination of the Pope and Turner ponds on Pine Tree Brook, used as sources of ice supply, and of the ice harvested therefrom, and in response to this request has caused these sources to be examined and samples of the water and ice to be analyzed.

The results of the analyses show that Pine Tree Brook receives considerable pollution, but the ice from the ponds indicated, while containing a somewhat larger quantity of organic matter than is usually found in good ice, was found upon examination to be clear and apparently free from particles of foreign matter, and bacterial examinations showed that very few bacteria were present. It was found that some of the ice harvested contained a thin layer of snow ice.

In the opinion of the Board, the clear ice harvested from these sources during the past winter may safely be used for domestic purposes. It is important that the snow ice be removed, and it is also important that all pieces of ice containing particles of foreign matter should be rejected.

Nantucket.

July 11, 1904.

To Mr. James H. Gibbs, *Nantucket, Mass.*

Dear Sir: — In response to your request of June 17, for advice as to whether the waters of Maxey's Pond and the north head of Hummock Pond are fit for drinking, and whether the ice from these ponds is fit to be used for family use, the Board has caused the ponds and their surroundings to be examined by one of its engineers and samples of water and ice from these ponds to be analyzed.

The ponds are located in an uninhabited region, and their water-sheds are free from population. The soil about them is sandy, and evidently very little water reaches them by direct flow over the ground.

The results of the analyses show the presence of considerable organic matter, evidently caused by the presence of plants and microscopic organisms in the water; but there is no reason to think that these waters are unsafe for drinking, though they may at times have an objectionable taste and odor.

The ice found in the ice houses upon the shores of these ponds contains particles of the vegetable matters present in the pond when the ice was formed; but the ice is in other respects of good quality and, in the opinion of the Board, this ice is safe for domestic uses.

PALMER (THREE RIVERS).

JULY 11, 1904.

To the Board of Health of the Town of Palmer, J. P. SCHNEIDER, M.D., *Chairman.*

GENTLEMEN: — In accordance with your request of June 13, for an examination of the ice sold in Three Rivers, Palmer, for domestic purposes, the Board has caused samples of ice at present in store in an ice house near the Quaboag River in Three Rivers, which the Board is informed was harvested from that river during the past winter, to be analyzed.

The Quaboag River drains a large area, and receives the sewage of Palmer, three miles above Three Rivers, beside much other pollution. A sewer from the village of Three Rivers discharges into the stream opposite the place from which the ice is cut.

The ice examined was found to consist of about six inches of clear ice and five inches of snow ice, evidently formed above the clear ice by rain or flooding. The results of an analysis of a sample of this ice show that the snow ice contains a large quantity of organic matter, and that the clear ice contains more organic matter than is found in good ice.

Considering the circumstances, the Board cannot regard this ice as safe for use where it may come in contact with food or drinking water.

QUINCY.

MARCH 3, 1904.

To the Board of Health of the City of Quincy.

GENTLEMEN: — In response to your application for an examination of the ice harvested from Furnace Pond by the Eaton Ice Company during the present winter, and advice as to its quality for domestic purposes, the Board has caused several examinations to be made while the ice was being harvested from this source, and several samples of the ice to be analyzed.

The results of the examinations show that the ice was planed or shaved before storing, and the snow ice and a considerable depth of the ice which first formed upon the pond were removed, and pieces of ice containing foreign matter were rejected. A considerable quantity of grass and other débris was floating in the water of the pond when ice first formed upon it, and was included in the first crop of ice; but nearly all of this floating material was subsequently removed from the ice by planing or shaving off a depth of several inches before storing it in the ice houses. The ice of this first crop, excepting portions containing foreign matter, was of good quality.

Analyses of several samples of the ice of subsequent crops show that the

number of bacteria present in this ice is not large, and none of the bacteria characteristic of sewage was found in the samples analyzed.

Under the circumstances, the Board is of the opinion that ice harvested from Furnace Pond during the present winter may safely be used for domestic purposes, provided that ice containing pieces of wood, leaves, grass or other foreign matters be excluded.

Westport.

July 21, 1904.

To the Board of Health of the Town of Westport.

Gentlemen: — The attention of the State Board of Health has been called to the condition of a pond on the Noquochoke River, situated in the village at the head of Westport River, the water of which is said to have been polluted by the discharge of sewage from mills upon the stream above during the past winter, when ice was harvested therefrom.

The Board has caused the locality to be examined by one of its engineers, and finds that the water entering this pond is polluted by the direct discharge into the stream of water-closets and privies in two factories, one of them within about a quarter of a mile and the other within about a mile above the pond.

An analysis of a sample of ice taken from an ice house on the shore of this pond, which consisted of about ten and one-half inches in depth of clear ice with about one and one-half inches of snow ice on top, was found to contain considerable organic matter, and a much larger number of bacteria than is found in ice collected from unpolluted sources. The Board is informed that this ice is not used for domestic purposes, and, in the opinion of the Board, it should not be so used.

If the use of this pond as a source of ice supply is to be continued, the sewage from the factories referred to should be diverted from the pond, and collected in privies or cesspools so located that no sewage can find its way into any of the streams which feed the pond.

Sewerage and Sewage Disposal.

The following is the substance of the action of the Board during the past year in reply to applications for advice relative to sewerage and sewage disposal: —

Brockton.

March 3, 1904.

To the Sewerage Commissioners of the City of Brockton.

Gentlemen: — In response to your communication of February 12, stating that the limit of the capacity of your present works for purifying sewage has been reached, and desiring advice as to methods of increasing the capacity of the purification works, the State Board of Health has caused examinations of the present condition of the filtration area to be

made, and has considered the information furnished by previous examinations and by the records of the operation of these works since they were first used.

The results of the examinations show that the capacity of the present filters for purifying thoroughly all of the sewage of the city of Brockton has practically been reached, and that additional capacity is required in order to provide adequately for the purification of the increasing quantity of sewage from the city.

The soil in areas adjacent to the sewage filter beds was examined very thoroughly by this Board previous to the construction of the present works, the results at that time showing that the best land in the vicinity of the present area for the extension of the filter beds was situated just west of them, within the limits of the town of Easton, this land being similar in character to that where the filter beds are now located, and superior in topography, character of soil and distance from habitations to land either east or north of the filter beds. These conditions have not changed in the years since that examination was made, and filter beds constructed on this land would be located farther from dwelling houses than the present filter beds.

In the opinion of the Board, the best practicable plan of increasing the capacity of the works for purifying the sewage of the city of Brockton is to construct additional filter beds upon the land in the town of Easton adjacent to the present filter beds, on their westerly side.

FAIRHAVEN.

AUG. 4, 1904.

To the Board of Sewer Commissioners of the Town of Fairhaven, Mass., MR. E. G. PAULL, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on July 26 the following application for advice with reference to a proposed system of sewerage for the locality known as Oxford Village, in the town of Fairhaven: —

The general plan is as shown with an outfall into "Acushnet River," so called, at the southerly end of Cherry Street. The outfall will be of iron pipe, carried out as far as may be deemed advisable. Sewers on the combined system are contemplated.

Of course the commissioners realize the lack of current in the immediate vicinity of Cherry Street, but by carrying the outfall out as above suggested, it is believed that the sewage will be diluted so as not to create a nuisance on the shore.

The general character of the soil in the district proposed to be sewered is gravelly, mixed with sand. The soil is extremely absorbent except near Cooke Street, where the hardpan is of great detriment to construction of satisfactory cesspools, and it is mainly the residents on this street who have pushed the matter of sewerage.

Good grades are obtainable in all streets shown on plan.

The water-shed east of Main Street is only shown very approximately, from a mere cursory inspection of the territory. The land is so nearly level and so very absorbent that it was not deemed necessary to make a topographical survey.

The sizes of pipe are based on an estimate of 25 acres, more or less, of impervious area as streets and houses in the future.

The present population of the district may be 300; but this section of the town is bound to increase rapidly in the next ten or fifteen years.

It is purposed this year to put in the trunk sewer in Cherry Street, and run through Cooke and Main streets, as shown in full lines. Next year the full line system will probably be completed, and there may be further extensions.

The application was accompanied by a plan of the projected sewer system for Oxford Village and of the proposed outlet, located at a point in New Bedford harbor about 250 feet from the shore at high water.

The Board has already considered a plan of sewerage for this village at a previous time, when it was proposed to discharge the sewer near Cooke Street; and at that time advised you as follows: —

It is probable, in the opinion of the Board, that, if the outlet of the proposed Cooke Street sewer should be carried farther to the south, to some point opposite the end of Oxford Street, or between there and the end of West Street, where deeper water can be reached at no great distance from the shore, the small quantity of sewage which this sewer will receive can be discharged into the harbor for a time without creating a serious nuisance. Sewage can be brought to this place by a pipe laid along the shore, or possibly by a sewer which would pass part of the way through private lands between North Street and Oxford Street. It is desirable, in the opinion of the Board, to keep storm water out of this sewer, and to dispose of the storm water by a separate channel, since this water, if unpolluted by sewage, can be discharged into the harbor at any convenient place without creating objectionable conditions.

In the opinion of the Board, it would be of much advantage to the town, since other sewers seem likely to be required for small sections in the northerly part of the town before long, to prepare a general plan for the sewerage of those portions of the town not now provided with sewerage. When such a plan has been prepared and a suitable outlet for the sewage selected, it will be possible to build local sewers from time to time, with temporary outlets, if suitable outlets can be found, in such a manner that these sewers can form part of a general system at some future time.

The Board has caused the locality to be examined by its engineer, and has considered the plan and the description of the proposed system.

The outlet now proposed, instead of being located near the point in the neighborhood of Oxford or West streets, as suggested in the communication of the Board quoted above, is located in the cove farther south, toward which the prevailing winds blow in summer; and, there being little or no current in this part of the harbor, floating matters deposited in the waters in the neighborhood of the proposed outlet would be carried quickly to the shore.

It would be practicable to carry the outlet farther west than the location now indicated, and to discharge the sewage into deep water off the point beyond West Street, where it is likely that this sewage can be discharged for a time without seriously fouling the water or the shores in the neighborhood; and the Board would advise that, if sewage is discharged into the harbor in this region, it be discharged at an outlet located off the point indicated, well beyond the shore at low tide.

The plan submitted is also objectionable in that provision is made for taking storm water into the sewers. It is likely that, if the population in this region grows rapidly, as now seems probable, it will be necessary to remove the sewage to some more suitable outlet farther south; and this can be done more economically if the sewers are built upon the separate plan than if they receive both sewage and storm water. Moreover, the storm water can be disposed of at convenient points on the shore, by means of comparatively short channels; and it will probably be less expensive to construct the works if the sewage is kept separate from the storm water, than by employing the combined system. The Board would, therefore, advise that the sewers be built for sewage only, and that the storm water be discharged through separate channels.

FALMOUTH.

MARCH 3, 1904.

To the Board of Health of the Town of Falmouth.

GENTLEMEN: — The State Board of Health received from you on February 18 plans of a proposed system of sewerage for the village of Falmouth Heights, which provide for collecting the sewage in a separate system of sewers, discharging into Vineyard Sound at two outlets, one at the westerly end of the village near Bowman's Pond, and the other at the easterly end of the village near Little Pond. It is proposed to locate the outlets about 100 feet beyond low-water line, where there is said to be a depth of about 8 feet of water at low tide. The principal part of the sewage of the village would, by this plan, be discharged at the easterly outlet, the westerly outlet being designed to serve only a few houses on the westerly slope of the hill.

The Board has caused the locality to be examined by one of its engineers, and has considered the proposed plan. No profiles or plans showing the slopes of the proposed sewers have been submitted, and the Board is unable to advise whether or not the proposed sewers are of adequate capacity for the removal of all of the sewage of the area which they are designed to serve.

The proposed outlets are objectionable on account of their nearness to shore, and the danger that solid matters from the sewage may be carried upon the beach, which, it is understood, is used for bathing by large numbers of people in the summer season. The westerly outlet seems likely to

be the more objectionable of the two. The number of houses which will be connected with the proposed sewer discharging at this outlet is small, and the sewage of these houses could probably be disposed of by cesspools without special difficulty or objection, until the locality becomes more densely populated.

No information is submitted to show the direction of the currents at different stages of the tide, and the Board is unable to advise as to the probable movement of the sewage if discharged at the proposed easterly outlet. There seems to be much danger, however, that floating matters from the sewage might be carried to the shore; and, if the sewage is to be discharged into the sound at this place, the Board would advise that the sewer outlet be carried out to a point at least 200 feet from the shore at low water, and that the sewage, before being discharged, be passed through a tank for the removal of floating matters. It would be practicable to purify this sewage upon land not far from the village, and avoid discharging it into the sea; but it would be necessary in that case to pump the sewage, and the cost of the works would be greater than the cost of discharging it into the sound. If the proposed outlet should become objectionable, however, the sewage could be disposed of on land.

Grafton (Colony for Insane).

Aug. 4, 1904.

To the Trustees of the Worcester Insane Hospital, E. V. Scribner, M.D., *Superintendent.*

Gentlemen: — The State Board of Health has considered your plans for the disposal of the sewage from buildings of the Grafton Colony of the Worcester Insane Asylum, in Shrewsbury, Grafton and Westborough. These plans provide for the disposal of the sewage of the women's building and power plant upon sand filter beds in Grafton, adjacent to the boundary line between Shrewsbury and Grafton, about 100 feet west of the boundary line between Grafton and Westborough.

The soil of this region, judging from surface indications and the material found in a test pit, is apparently composed of porous material, suitable for the purification of the sewage by intermittent filtration; and, in the opinion of the Board, it is probable that filter beds can be constructed in this vicinity upon which it will be practicable to purify efficiently the sewage of the buildings.

The plans show a small filter bed located south of the Boston & Albany Railroad tracks and about 800 feet south of the filter bed referred to above, which is to be used for the disposal of the sewage of several buildings in this neighborhood. A test pit dug at the location of these beds shows that the soil is very fine; but, judging from surface indications, the land farther down the hill near the railroad is composed of material suitable for the purification of sewage by intermittent filtration.

The sewage of a building located in the northerly portion of the area is

also to be disposed of upon a sand filter bed. It would be practicable to convey the sewage into the sewer which removes the sewage from the power house and the women's building, and this may be the best plan of disposing of this sewage. The quantity of sewage to be disposed of from this building will be very small; and, unless the building is enlarged or others should be built in this neighborhood, it will probably be best to dispose of the sewage upon artificial filter beds near the building. There is no soil suitable for the purpose available in the neighborhood, but filters can undoubtedly be constructed by hauling sand or gravel from other portions of the land owned by the hospital.

No details of any of the proposed filter beds are shown on the plans submitted; and, as already indicated, the character of the soil at the place at which it is proposed to construct filter beds has not yet been examined sufficiently by means of test pits. The soil should be carefully examined before the sewers are built, in order that suitably constructed filter beds of ample area shall be provided at each place. When you have prepared further details of the plans of sewage disposal, the Board will, if you so request, advise you concerning them.

You have also requested advice as to the proposed water supply for the institution. Two sources have been indicated by you: one being a spring south-west of Green Hill and a short distance north of the water tower; and the other, springs near the Boston & Albany Railroad, south-west of the proposed sewage-disposal area. An analysis of the water of the first-mentioned spring shows that it is of excellent quality for drinking purposes, and the quantity flowing at the time the examination was made would be ample for the present requirements of the institution. The springs near the railroad are located at a much lower level; but it is probable that water of excellent quality can be obtained from the ground at this place, and in larger quantities than from the spring near the water tank. While a sufficient supply can doubtless be obtained for the present from the spring near the water tower, and the expense of obtaining a supply from that source would be less, the board would advise that the water of the springs near the railroad be also carefully protected from pollution, since that source is a desirable one, and is likely to be required at some future time.

Great Barrington.

March 3, 1904.

To the Sidewalk and Sewer Commissioners, Great Barrington, Mass., Mr. John K. Siggins, *Clerk.*

Gentlemen: — The State Board of Health received from you on Feb. 8, 1904, plans of sewerage for two small districts, containing together about forty dwelling houses, in the northerly portion of the village of Great Barrington, — one on the easterly and the other on the westerly side of the Housatonic River, — which provide for collecting the sewage into a

system of pipe sewers, and for outlets into the Housatonic River above the Russell mill dam, so called. The sewer on the easterly side of the river will, according to the plan, discharge into the river about 350 feet above the dam and about 30 feet from shore; that on the westerly side will discharge into the river about 2,400 feet above the dam and about 30 feet from shore.

The Board has caused the conditions about the proposed outlets to be examined by one of its engineers; and having carefully considered the proposed plans, concludes that the discharge of sewage from the small areas indicated on the plan into the Housatonic River at the outlets shown is permissible under existing conditions, and advises the adoption of these plans for the disposal of the sewage from these areas. The Board would advise that in the construction of these sewers surface and roof water be excluded, and that in general in the construction of sewers in the town the separate system of sewerage be employed; since it may be necessary at some future time to remove all of the sewage from the proposed outlets and from the various existing outlets in the village to some place of disposal farther down stream, and in that case much expense would be saved if the storm water is kept separate from the sewage. The storm water can be discharged into the river or its tributary streams at convenient points in the village without causing objectionable conditions.

HAVERHILL.

OCT. 6, 1904.

To the Hon. ROSWELL L. WOOD, *Mayor, Haverhill, Mass.*

DEAR SIR: — The State Board of Health received from you on Sept. 3, 1904, an application for advice as to an outlet for a proposed system of sewers in the Front Street district, so called, in the section of the city formerly included in the town of Bradford, and for advice relative to proposed plans for relief of the present sewer system in ward 6, in the northwesterly portion of the city, by separating the sewage from the storm water in a portion of the district, and by providing an overflow for the relief of the sewers in other portions of the district, in time of rain, by discharging a part of the mingled sewage and storm water at such times into a mill pond on Little River or tributaries of that stream. The plans showing the details of the proposed method of collecting and disposing of the sewage in the latter areas were submitted with the application.

The proposed plans for the sewerage of the Front Street district provide for constructing sewers in substantial accordance with plans considered by this Board at a previous time, which provided for the construction of sewers to receive both sewage and storm water. It is now proposed, in constructing the outlet for this system, to discharge the dry-weather flow of sewage through a submerged outlet about 160 feet from the south bank of the river at ordinary high water, allowing the excess of flow of mingled

sewage and storm water at times of storm to discharge at the edge of the river. The Board is informed that a sump, or sand-catcher, is to be placed in the bottom of the Front Street sewer above the upper end of the submerged outlet, to collect sand and similar materials which might tend to obstruct the pipe.

The Board has considered the plan of the proposed outlet, and has caused the locality to be examined by one of its engineers. It is very important, in the opinion of the Board, to discharge the dry-weather flow of sewage from this outlet at a considerable distance from the shore, since there is an eddy along the shore at this place, in which the sewage, if discharged at the edge of the stream, would be liable to collect and create a nuisance. There is no reason why a submerged outlet, as proposed, should not operate satisfactorily at this place if properly constructed, provided it receives the necessary care to insure the removal of sand from the sump and matters which might tend to clog the submerged pipe.

The territory considered in the proposed plans for changes in the sewerage and drainage system in the north-westerly part of the city is included approximately between Round Pond on the east and Little River on the west, and between Eleventh Avenue and Sheridan Street on the north, and John Street, Fourth Avenue and Howard Street on the south. This district includes nearly 350 acres, practically all of which is within the water-shed of Little River. The sewage of the district is at present removed in a marginal sewer, so called, in the valley of Little River, through which it is conveyed to the Merrimack River.

The southerly portion of this district is already served by a combined system of sewers, while in the northerly portion the sewers are constructed almost entirely upon the separate plan. It is now proposed to extend the separate system in the northerly part of the district to include about 162 acres, by discontinuing all connections through which storm water is now discharged into the sewers, and by providing at the same time a general system of storm-water drains to convey the storm water to a small tributary of Little River, allowing the sewage to flow as at present into the main sewer in the Little River valley.

It is proposed to divide the southerly portion into two parts of nearly equal size, in the northerly of which it is proposed to introduce gradually the separate system, while in the southerly portion the use of the combined system will be continued. By this plan the storm water in these two areas, comprising 184 acres, will in part continue to flow in the same channels with the sewage for the present; and, in order to obtain relief from the overflowing of the sewers in the low part of these areas at times of heavy rain, it is proposed to provide an outlet into Little River, through which the excess of flow of mingled sewage and storm water above the capacity of the main sewer in the Little River valley may be discharged into the mill pond on Little River.

The proposed overflow, as indicated upon the plans submitted, will run westerly from Primrose Street through a proposed street, and, after crossing Hale Street, will pass through private land under the Boston & Maine Railroad to the Little River. Between Primrose and Hale streets the outlet will have a diameter of 60 inches. It is proposed at the present time to build only the portion of this outlet lying between Primrose and Hale streets, and to extend a 36-inch pipe northerly in Hale Street to a small arm of Little River, and subsequently to extend the main outlet from Hale Street to the river, reducing its diameter to 44 inches. Storm-water overflows will be provided from the sewers which receive storm water, by which the excess of flow in the combined sewers in the district indicated will be discharged through this outlet at times of storm.

The Board has considered the plans and the information submitted, and concludes that there will be no objection to the discharge of storm water, if unpolluted by sewage, into Little River or any of its tributaries; but that, if any considerable quantity of sewage should be discharged into Little River, a serious nuisance would be likely to result. The district under consideration is not at present thickly populated, however, and it will be practicable, under existing conditions, by building storm-water drains, to prevent the overflow of sewage except in heavy storms and at infrequent intervals; and, if mingled sewage and storm water are discharged into Little River above the dam at Winter Street at such times only, the Board is of the opinion that objectionable conditions are unlikely to result. If the sewage should be discharged into the small arm of Little River east of the railroad, as proposed, a nuisance might be created.

The expense of extending the 60-inch sewer or drain directly to Little River at its full size in the beginning will not be greatly in excess of that of the plan now proposed; and, in the opinion of the Board, it is important that in this respect the plans be modified, and the drain be extended to Little River in the beginning. With this modification, the Board is of the opinion that the plan is an appropriate one for the sewerage of the district in question, and for removing the objectionable conditions now existing by the overflow from existing sewers in this area.

Nov. 3, 1904.

To the Board of Harbor and Land Commissioners, MR. WOODWARD EMERY, *Chairman.*

GENTLEMEN: — Since the receipt of your communication of November 1, the Board has caused the location of the proposed sewer outlet at Haverhill to be examined by its engineer, to determine whether any objection exists, from a sanitary point of view, to the discharge of sewage at the point indicated upon the plan submitted by you, — about 75 feet from the shore at high water; and finds that the bottom of the river in this region is somewhat uneven, and that a small area is exposed beyond the pipe at extreme low water.

Considering the circumstances, the Board is of the opinion that, if the sewer pipe should be extended 50 feet beyond the terminus indicated on your plan, objectionable conditions are unlikely to result.

Holyoke.

Sept. 1, 1904.

To the Board of Public Works of the City of Holyoke.

Gentlemen: — The State Board of Health has considered your request for advice as to a modification of the plan for the disposal of the sewage of the Highland district, so called, in the city of Holyoke, and has caused the locality to be examined by one of its engineers.

The question of the disposal of the sewage from this district has already been considered by the Board in response to previous requests of the city of Holyoke; and, as the matter now stands, the plans which have been proposed by the city and the adoption of which has been advised by the State Board of Health provide for conveying this sewage through a sewer to be laid along the westerly bank of the Connecticut River to a junction with the Walnut Street sewer, so called, whence the sewage of both sewers is to be conveyed into a main sewer having an outlet into the Connecticut River below the city; so that, when these plans have been carried out and the necessary sewers have been built, all of the sewage of the city will be discharged below the dam.

You now request the advice of the Board as to a modification of this plan, and have presented a plan which provides for collecting the sewage of the Highland district at the head of the dingle, so called, — a ravine through which the surface water now runs to the Connecticut River, — and conveying it through a 10-inch iron pipe across the island which has formed near the westerly bank of the river to a point of discharge in the Connecticut River east of the island and about midway between the island and the South Hadley shore; and you request the advice of the Board as to the disposal of the sewage of the Highland district in this way for a period of from five to seven years, at the end of which time you propose to dispose of it in connection with the sewage discharged at the Walnut Street outlet, according to the plan outlined above.

The Board has carefully considered this plan, and concludes that sewage discharged at the proposed outlet would quickly mingle with the water of the river, and would not create a nuisance in the neighborhood; but the sewage-polluted water will be quickly carried into the canals in the city, whence it is drawn by the mills for various mechanical and manufacturing purposes, and is liable to be used for drinking.

The Board believes it important for the city to remove all of the sewage to some point of discharge below the Holyoke dam. The saving in expense to the city by constructing the temporary outlet now proposed and using it for a period of from five to seven years would not be great; and

the Board believes the better plan for the city of Holyoke to adopt would be to convey the sewage in the beginning to a point of connection with the Walnut Street sewer, as provided in the plans presented to this Board in 1900.

Hubbardston.

July 7, 1904.

To the Board of Health of the Town of Hubbardston, W. T. Knowlton, M.D., *Chairman.*

Gentlemen: — The State Board of Health has considered your request for advice as to the removal of certain unsanitary conditions in the village of Hubbardston, which you describe as follows: —

> At the present time the surface water from the main street of the town is collected into two main drains or ditches, and this is emptied onto private land. This land is low, and the water accumulates, forming a long, shallow body of stagnant water, within a very short distance of numerous wells used for drinking purposes. After a heavy rain the conditions are greatly aggravated. Certain wells at this time are unfit for use, owing to surface water which percolates into them. This condition has existed for a long time.
>
> Now, I would like to ask if the Board will . . . look into this condition, and suggest a means to remedy the present nuisance. It is a constant source of menace to health, as there have been several cases of typhoid and a number of cases of intestinal disorders that have fallen under my notice.

In response to this application, the Board has caused the locality to be examined by one of its engineers and samples of water from wells in the locality indicated to be analyzed.

As a result of the examination, it appears that surface water from the northerly end of the village flows naturally to a swampy area, just west of the main street, and that drains have been constructed to convey the surface water to this area, which discharge not far from the westerly side of the street. The swampy area into which these drains discharge is bordered with dwelling houses not much above the level of the swamp, and sewage from these houses, as well as from others in the neighborhood, is discharged upon this area or into adjacent ditches. Attempts appear to have been made to drain the swamp, but the drains dug for this purpose are ineffective.

Analyses of samples of water from two of the wells near the edge of the swamp used as sources of drinking-water supply show that they are grossly polluted by sewage, and other wells in this locality are probably also seriously polluted by sewage.

It is evidently practicable to drain the meadow and prevent surface water from standing thereon and flooding the wells, and it is very desirable that this area should be drained, for sanitary reasons; but the soil in this region is very fine and nearly impervious to water, and a nuisance would probably continue to exist by reason of the disposal of sewage from the dwelling houses in this region, and some means of disposing of this sewage is also required.

A survey will be necessary to determine the best method of improving these conditions, and the Board would advise that you have an investigation made, and a plan for the drainage of this section and the disposal of the sewage prepared. When the results of further investigations are available, the Board will, upon application, give you further advice in this matter.

The most serious injury to health caused by the conditions now complained of is probably caused by the pollution of the wells in this neighborhood, and the Board would advise that the further use of water from these polluted wells be prevented at once. An examination of wells in other parts of the village of Hubbardston shows that many of them are badly polluted by sewage.

A public water supply is greatly needed in this village, and there are sources in its immediate neighborhood from which an adequate water supply could apparently be obtained with little difficulty and at a reasonable expense. Many villages of similar size are already provided with such supplies, and the Board would advise the town to take measures without delay to determine the probable cost of a public water supply, with a view to the introduction of such a supply as soon as practicable.

LENOX.

JULY 7, 1904.

To Messrs. H. D. KENDALL, RICHARD C. BRINE and T. F. MACKEY, *Sewer Commissioners of the Town of Lenox.*

GENTLEMEN: — The State Board of Health has considered your application for advice with reference to enlarging the filtration area of the town of Lenox and the plans of the proposed new filters submitted therewith, and has caused the locality to be examined by one of its engineers.

The plans submitted provide for four filter beds, having an area of a little less than one and one-half acres, including the embankments. It does not appear that any preliminary examinations of the soil at the location of these filter beds were made; and from such information as the Board has collected, it appears that the soil is extremely fine, and not suited to the purification of sewage.

An examination of the ground on the slope of the hill not far from the location of the proposed filter beds shows that in some places at least the soil consists of gravel and sand of good quality for the purification of sewage by intermittent filtration, and it appears that some of this land is now used for the disposal of a small quantity of sewage by means of trenches.

The Board would advise that a careful examination of the soil in this region be made by means of test pits, to determine whether it is practicable to secure a sufficient area of land containing porous soil for the purification of the sewage of Lenox, so located that its use for purposes of sewage purification would not be objectionable. If it is not practicable to find

such an area, investigations should be made to determine whether it will be practicable to construct a sufficient area of filter beds for the purification of the sewage by the use of suitable material obtained in some other locality.

The Board will, upon application, give you further advice in this matter when the results of further investigations are available.

SEPT. 1, 1904.

To Messrs. HENRY D. KENDALL, RICHARD C. BRINE and T. F. MACKEY, *Sewer Commissioners of the Town of Lenox.*

GENTLEMEN: — In response to your application of Aug. 8, 1904, in which you state you have made further investigations as to the disposal of the sewage of the town of Lenox, and now desire further advice from the Board as to the disposal of the sewage and as to the possible danger of the contamination of the water supply of the New York, New Haven & Hartford Railroad Company at Lenox station by sewage or effluent from the proposed works, the Board has considered the further information presented, and has caused a further examination of the locality to be made by one of its engineers.

It appears that test pits have been dug on the slope of the hill below the filter beds proposed in your last communication and that the soil found beneath a layer of loam in the northerly portion of the land owned by the town consists of gravel and sand suitable for the purification of sewage by intermittent filtration; but the layer of porous soil is underlaid by a stratum of fine material unsuitable for the purification of sewage, and the depth of the porous layer is in some places slight.

It appears, from the investigations, to be practicable to construct in this locality a limited area of filter beds of suitable character for the efficient purification of sewage by intermittent filtration; but the information furnished by your investigations is insufficient to make it practicable to determine whether a sufficient area of filter beds can be constructed by the use of the porous material in this locality to provide adequately for the purification of all of the sewage of Lenox. The cost of constructing filter beds from the porous material found in the northerly portion of the area now owned by the town would probably be large, since it would probably be necessary to move much of the material in order to secure filter beds of sufficient depth; and, considering the limited area of filter beds that could probably be made available at this place, it is desirable to make other investigations in this region, to determine whether filters of adequate area for the purification of the Lenox sewage cannot be constructed at some other place in this region at a less expense than on the area now in use.

The two filter beds recently constructed and now nearly completed contain soil so fine that water from the rainfall apparently remains upon the surface for a long time after the rain has ceased, indicating that little if any sewage would pass through these beds.

It is understood that you propose to lay underdrains 15 feet apart in these beds, and to refill the trenches over the underdrains with sand and gravel. If this should be done, these filters would pass some sewage, but their capacity would be limited by the area of the porous material over the underdrains.

The Board would advise that a further and more thorough investigation be made of the areas available for the purification of the sewage of Lenox; and, when further investigations have been made and plans for the disposal of the sewage prepared, the Board will, upon application, give you further advice in this matter.

An examination of the locality from which the water supply of the Lenox station is now taken shows that the source would not be likely to be affected by the disposal of sewage at the place now proposed; but, if the sewage should be disposed of on the porous soil near the northerly limits of the area owned by the town, it is possible that the source of water supply might be polluted by the sewage; and it is advisable, in the opinion of the Board, that, if the area indicated should be used for the disposal of sewage, the use of water from the present source of supply be discontinued and a supply secured from another source. It is probable that water could be obtained from some point farther up the valley.

LEOMINSTER.

APRIL 7, 1904.

To Messrs. A. L. WHITNEY, W. H. CHASE and C. H. HOWE, *Sewerage Committee of the Town of Leominster.*

GENTLEMEN: — On March 4, 1904, the State Board of Health received from you the general plans of a system of sewerage and sewage disposal for Leominster, which provide for collecting the sewage of all of the thickly settled portions of the town in a separate system of sewers, discharging by gravity upon filter beds bordering the north branch of the Nashua River on its south-westerly side, north of Mechanic Street, where it is proposed to purify the sewage by intermittent filtration.

The Board has already considered the propriety of using the area indicated for the disposal of the sewage of the town, and has advised your committee, under date of Nov. 5, 1903, that the proposed location was not objectionable, and that excellent material was available at this place for the construction of a sufficient area of filter beds upon the low land near the Nashua River to purify the sewage of the town.

The Board has considered the additional plans now presented, showing the proposed main sewers and further details as to the construction of the proposed filtration area, and finds them to be well adapted to the collection and efficient purification of the sewage of all of the thickly settled portions of the town.

The proposed settling tank at the filtration area is of sufficient size for

the requirements of the town in the beginning, at least, and can be enlarged in future if necessary.

The area of filter beds shown should be ample for a long time in the future, and it will be necessary to prepare only a portion of this area in the beginning, if the storm water which is admitted to the present sewers shall be excluded, and care taken in the construction of future sewers to exclude ground and surface water so far as practicable.

In the opinion of the Board, works constructed in general accordance with these plans would provide satisfactorily for the collection and disposal of the sewage of the town of Leominster.

MANCHESTER.

JUNE 2, 1904.

To the Board of Health of the Town of Manchester, MR. WILLIAM H. ALLEN, *Chairman.*

GENTLEMEN: — The State Board of Health has considered your application for advice with reference to the disposal of night soil in Manchester by discharging it upon a certain tract of land north of Lincoln Street, and has caused the locality to be examined by one of its engineers.

The results of this examination show that the area which it is proposed to use is located about 600 feet from your present sources of water supply, and at a higher level; and, while some tests have been made in this neighborhood to show the depth to ground water, it is impracticable to determine, from the information now available, whether leachings from night soil deposited upon this area would flow in the direction of the wells and affect the quality of their waters, or not.

It is essential to avoid the possible danger of the pollution of your sources of water supply; and, under the circumstances, the area indicated should not, in the opinion of the Board, be used as a place of disposal for night soil. An area should be secured, as you have already been advised, at some place where this material can be disposed of without danger of affecting your sources of water supply.

This matter can be disposed of without objection by dumping it at sea, provided it is conveyed to a sufficient distance from any shore so that it may become mingled with the water and completely broken up before it can return; and the plan of disposing of the night soil in this way, until such time as a sewerage system is available, will probably be the least objectionable one to adopt.

MARBLEHEAD.

APRIL 7, 1904.

To the Sewerage Committee of the Town of Marblehead.

GENTLEMEN: — The State Board of Health received from you on March 30, 1904, an application for further advice relative to the sewerage of the town of Marblehead, accompanied by plans showing a system of sewers having an outlet about 400 feet south-east of Tinker's Island, and by a

report giving an estimate of the cost of the disposal works, together with observations of the movements of floats at the proposed point of discharge, as suggested in the communication of this Board on June 4, 1903; and the Board has carefully considered the modified scheme now submitted.

Sewage discharged south-east of Tinker's Island would not be noticeable from the mainland, and there is apparently a considerable tidal current setting between the island and the shore of the mainland which would have a tendency to keep floating matters from returning upon these shores; and the limited number of float experiments made all show that the floats moved in a direction parallel with the shore, none of them showing a tendency to come upon it. The outlet proposed is a very favorable one for the disposal of sewage, and, in the opinion of the Board, the sewage of Marblehead can be effectually disposed of by discharge into the sea at the point indicated, — 400 feet or more south-east of Tinker's Island, — without danger that the sewage will return to the shores of the mainland or create a nuisance anywhere.

The further investigations as to the sewerage of the town have shown that it is practicable to collect the sewage of the greater portion of the town at a point near the south-easterly shore of Marblehead Neck by gravity. It appears to be necessary to omit from this plan a low area in the extreme north-easterly end of the town, including a portion of the main village; and the plans provide for collecting the sewage of this area at a reservoir and pumping station to be located at the shore of Little Harbor, near the gas works, from which it is to be pumped into the main system.

A small area in the extreme south-westerly part of the town, adjacent to the town of Swampscott, has been omitted from the present plan, as was the case last year, since it would be less expensive to pump the sewage of this area into the main sewer, when sewerage becomes necessary, than to lay the main sewer in this region at a sufficiently low level to serve this area. There is a similar low area in Swampscott, adjacent to the Marblehead area, which cannot be served by gravity by the Swampscott sewers; and it may be possible for the two towns to effect some joint plan of collecting and disposing of the sewage of these areas which will be less expensive than the collection and disposal of the sewage by each town separately.

While it is necessary, under the plan now proposed, to maintain two pumping stations, the estimates of cost submitted by your engineer indicate that the expense of collecting and disposing of the sewage of Marblehead into the sea off Tinker's Island in a satisfactory manner would be materially less than the cost of disposal in the neighborhood of Gray's Rock, should it be practicable to find a desirable outlet in that locality.

The plan in general, in the opinion of the Board, provides a practicable method of collecting and disposing of the sewage of the town of Marble-

head in a satisfactory manner. When further details of the proposed system have been prepared, the Board will, upon application, give you further advice concerning them.

NORTHAMPTON.

MARCH 7, 1904.

To Mr. THEOBALD M. CONNOR, *City Solicitor, Northampton, Mass.*

DEAR SIR: — In response to your communication of March 3, requesting, on behalf of the city of Northampton, an extension of time for compliance with the present requirements for the extension of its sewers to the Connecticut River, in order that the city may investigate other schemes or plans, the State Board of Health directs me to inform you that it will grant such extension for a period of one year from Dec. 1, 1904, provided the city authorities of Northampton display due diligence in prosecuting the investigations as to modifications of the plans.

DEC. 1, 1904.

To Mr. THEOBALD M. CONNOR, *City Solicitor, Northampton, Mass.*

SIR: — The State Board of Health received from you on November 28 the following request for approval of certain plans for the disposal of sewage of the city of Northampton: —

The undersigned, for the city of Northampton, respectfully presents the report of its engineers upon the question of sewage disposal, and hereby respectfully requests the approval of your Honorable Board of the first project for sewage disposal contained in said report, commencing with the last paragraph on page 8 of said report and ending with the first paragraph on page 15 of said report, — the same being contained in the report of Allen Hazen; and more particularly, first, for the location of a storm overflow to Mill River, at a point 1,200 feet more or less below the Wright Avenue bridge, to take the place of the present objectionable overflows at Wright Avenue bridge and at Williams Street; and, second, for the use of the present outlets to Mill River below the inhabited portion of the city for the dry-weather flow of sewage for a further period of ten years from Dec. 1, 1905.

Your application is accompanied by reports by Messrs. Allen Hazen and Ernest W. Bowditch, civil engineers, relative to the sewerage system of the city of Northampton, and by plans showing various methods of sewage disposal, including the project referred to in your application.

The sewerage system of the city of Northampton, constructed under the provisions of chapter 354 of the Acts of the year 1888, has been extended over the greater part of the built-up portion of the city, part of the system receiving sewage only, but a large part receiving both sewage and storm water. The area served by the combined system amounts, according to your engineers, to about 760 acres; and, in addition to the surface water received from this area, roof water from about one-half of the roofs of the houses of the city is also taken into the sewers.

In addition to the pollution which the river receives above the main sewer outlets from the overflow of sewage from combined sewers at times

of rain, the sewage from practically all of the factories along the river, in which about 1,270 operatives are employed, is discharged into the stream, and additional pollution is caused by the discharge of manufacturing wastes from many of the mills. The stream is very offensive in the warmer portion of the year, from the neighborhood of the Wright Avenue bridge to the Connecticut River.

The Board, in 1903, approved the plan of constructing a sewer to remove the sewage and other pollutions from this portion of the river to the Connecticut River. The plan of relief mentioned in your application is intended as a substitute for this sewer. This plan is more fully described in the report of your engineer, as follows: —

Extend the 4-foot sewer as a 54 and 60 inch sewer at a flatter grade from Wright Avenue through Pleasant Street, to a point about 300 feet below Meadow Street. At this point provide a large overflow to Mill River, carrying it well into the thread of the stream. Connect with the present 24-inch sewer to the present lower outlet, and allow the dry-weather flow to go in that way. Require Belding & Brothers' silk mill to connect with the existing sewers, and clean up the brook leading to the river just above Wright Avenue bridge. Clean up the channel of the river from the overflow below Meadow Street to the Connecticut River, removing obstructions, and giving as direct a channel as possible.

The only material change in the present condition of the river which would be effected by this project would be the removal of the pollution of the river in the neighborhood of the Wright Avenue bridge now caused by the manufacturing wastes from the Belding & Brothers' silk mill and the overflow of sewage from the main sewer. A new overflow would be created about 300 feet below Meadow Street, the discharge from which would be somewhat less than from the present overflow if the King Street brook should be diverted north-easterly toward the Connecticut River, as suggested. By the expenditure of $2,000 in cleaning the main stream and improving Mill River between the sewer outlets and the Connecticut River, the débris of various sorts which now clogs the bottom and sides of the stream could be removed and the channel improved to some extent; but the condition of this portion of the river, which is offensive throughout its length, and through which there is very little flow of water to dilute the sewage — especially at night or on Sunday — in warm weather, would continue to grow worse as the population of the city and the quantity of sewage and manufacturing waste increases.

The carrying out of the proposed plan would not, in the opinion of the Board, effect a material improvement in the objectionable conditions now existing in Mill River; and the Board is unable to approve the proposed plan as a substitute for the plan approved last year for diverting the sewage from Mill River to the Connecticut River.

A second project, described by your engineer, provides for conveying

the dry-weather flow of sewage to the Connecticut River in a pipe 24 inches in diameter, which would have a carrying capacity estimated by your engineers to be between 5,000,000 and 6,000,000 gallons per day. If the sewers of the city had been constructed on the separate plan, a sewer of smaller size than the one approved by this Board in 1903 would be sufficient for the removal of the sewage of the city to the Connecticut River; and if the system should now be changed gradually, so that the sewage would ultimately be kept separate from the storm water in all parts of the city within the next ten years, it would be reasonable to build a smaller sewer at present; but the sewer proposed in the second project, described in your engineer's report, would be no more than sufficient for the present dry-weather flow of sewage for the city, and it is not unlikely that the dry-weather flow of sewage would exceed its capacity at times when the ground-water levels are high. The Board cannot approve the construction of a sewer of the size proposed as a substitute for the one already approved.

It appears from the investigations of your engineers that it would be practicable to convey the sewage from about four-fifths of the population of the city to the low lands bordering the river, and dispose of it by applying it to the land; but that the cost of disposing of the sewage in this way would be considerably greater than the cost of conveying it to the Connecticut River through a sewer of adequate size.

The plans submitted do not show a practicable way of preventing further serious pollution of Mill River at less expense than by the construction of the sewer approved by the Board last year, and which, by the requirements of the statutes, is to be constructed before Dec. 1, 1905.

It is very desirable, in the opinion of the Board, to keep the sewage out of Mill River, and this can be done by separating the sewage from the storm water in areas served by combined sewers, by diverting the roof water from the sewers, and by causing the factories and mills to discharge their sewage into the sewers and continuing the sewers to the Connecticut River. If the city desires to provide for the gradual separation of the sewage from the storm water within a definite period, the Board will consider the approval of a plan for the immediate construction of a sewer of smaller size than the one approved last year.

NORWOOD.

AUG. 10, 1904.

To the Board of Selectmen of the Town of Norwood, MR. FRED L. FISHER, *Chairman*.

GENTLEMEN: — On Sept. 19, 1903, your Board was notified of the order of the State Board of Health prohibiting all persons from discharging or permitting the entrance of sewage into any part of the Neponset River or its tributaries, and from discharging or permitting the entrance therein of every other substance which may be injurious to the public health, or may

tend to create a public nuisance, or to obstruct the flow of water, including all waste or refuse from any factory or other establishment where persons are employed, unless the owner thereof shall use the best practicable and reasonably available means of rendering such waste or refuse harmless.

It now appears, upon further examination, that nothing has been done to remove from the river the sewage discharged into the stream at Dean Street from a sewer of the town of Norwood.

The State Board of Health, in accordance with a request from the authorities of the town of Norwood, in 1901, for advice as to the best practicable method of disposing of the sewage of the town, advised the purification of this sewage upon land south of the Neponset River, not far from the ink works in Norwood. This plan is described in the report of the committee on sewerage for the town of Norwood in 1901; and by constructing such portion of the main sewer as is necessary to divert the sewage from the present sewer and carrying it to the filtration area, and building a sufficient area of filter beds for the proper purification of this sewage, the further pollution of the river can be prevented; and this, in the opinion of the Board, is the best practicable and available plan of preventing the further pollution of the river by this sewer. It is practicable for the town, by proceeding diligently with the work, to complete the construction of the necessary works within the next four months.

The State Board of Health hereby notifies the town of Norwood to cease from discharging unpurified sewage from the Norwood sewer into the Neponset River or any of its tributaries on and after July 1, 1905.

NORWOOD (WINSLOW BROTHERS & SMITH COMPANY).

JULY 7, 1904.

To WINSLOW BROTHERS & SMITH COMPANY, *Norwood, Mass.*

GENTLEMEN: — The State Board of Health received from you on June 3, 1904, an application for advice with reference to plans of proposed settling basins and filter beds for your tannery at Norwood, concerning which you make the following statement: —

These plans apply to our Winslow Plant and we feel that they are large enough to care for our sewage for a number of years to come. About a year ago this time, after very careful measurements, we found the average amount of sewage matter to be four hundred and fourteen thousand gallons (414,000) per day of ten hours and at that time our plant was running at its full capacity. We have added somewhat to our plant since then but we feel confident that the increase in the amount of water used is not over twenty thousand gallons per day. In regard to increasing the capacity of our sewerage plant, we can build additional settling basins either to the north or south of those shown on the plan and in the area covered by the title and designated as "Bog" we can by simply filling, construct from three to four acres more of filter beds.

Two plans were submitted with the application, one showing the details of the proposed settling basins, and the other the general plan of the settling basins and filter beds, including the location of a collecting well or basin and pump, by which all of the sewage is to be pumped to the filtration area.

The Board has caused the locality to be examined by its engineer, and has considered the plans submitted by you and the results of investigations as to the quantity and character of the manufacturing wastes discharged from this plant in previous years.

It appears from the measurements of the quantity of foul wastes flowing from this tannery, presented by you, that there was a considerable increase in the quantity of such wastes from 1901 to 1903; and you estimate that there has been an increase of 20,000 gallons per day in the past year, making the quantity of foul wastes flowing from the tannery at the present time about 434,000 gallons per day. In addition to this quantity, a large quantity of water is used in the rinsing of wool after scouring, and some of this water is considerably polluted; but the Board is informed that it is proposed to use this rinse water hereafter in the other processes, so that no polluting drainage will be discharged into Hawes Brook from your works.

The proposed settling tanks indicated upon the plans submitted are six in number, and have an aggregate capacity of 562,500 gallons, the capacity being such that, with one tank out of use for cleaning, the sewage will be about a day in passing through the tanks. No provision has been made, however, for removing the solid matter from these tanks, other than by carting it away after it has been allowed to dry for a time; and, under the circumstances, there are likely to be times when more than one of the tanks will be out of use, and the sewage will pass through the tanks more rapidly than proposed. It is practicable to construct sludge beds upon the boggy area near the settling tanks, using gravel and sand from the adjacent upland, and to empty the tanks upon such beds by gravity as frequently as might be found desirable; and the tanks could be operated more efficiently and economically under such conditions than by the plan now proposed. The Board would advise that the design of these tanks be modified, that sludge beds be constructed upon the low area indicated, and that adequate provision be made for emptying the tanks upon the sludge beds whenever necessary. An area of 2 acres of sludge beds will probably be sufficient in the beginning, but experience may show that there would be advantage in the use of a larger area.

Examinations of the soil of the area upon which it is proposed to locate the filter beds have shown that much of it is very coarse and porous, and well adapted to the purification of the wastes from this tannery in the condition in which they have been found by investigations made by this Board in previous years.

Underdrains are shown beneath each of the beds, but the depth of these drains is not indicated. The underdrains should be laid at least 5 feet below the surface of the filter beds. It is probable that the underdrainage indicated will be sufficient, provided care is taken in laying the drains, to allow the effluent to enter them freely, and prevent their being clogged by sand or other material washed in through the joints.

The total area of filter beds indicated upon the plan is insufficient for the purification of all the wastes discharged from this tannery, and, in order to secure efficient purification of these wastes, a larger area will be necessary; and the Board would advise that at least 8 acres of filter beds be constructed, and provision made for further enlargement of the area whenever necessary.

AUG. 10, 1904.

To the WINSLOW BROTHERS & SMITH COMPANY, *Norwood, Mass.*

GENTLEMEN: — On Sept. 19, 1903, you were notified of an order of the State Board of Health, acting in accordance with the provisions of chapter 541 of the Acts of the year 1902, prohibiting all persons and corporations from discharging or permitting the entrance of sewage into any part of the Neponset River or its tributaries, and from discharging or permitting the entrance therein of every other substance which might be injurious to public health or might tend to create a public nuisance or to obstruct the flow of water, including all waste or refuse from any factory or other establishment where persons are employed, unless the owner thereof shall use the best practicable and reasonably available means to render such waste or refuse harmless; and on July 7, 1904, the Board, in further compliance with the provisions of the above-mentioned act, advised you as to certain plans for purifying the sewage and manufacturing waste and refuse from your factory, submitted by you on June 3, 1904, advising that tanks and filters built in accordance with the proposed plans would purify efficiently the sewage and waste liquors from this tannery, if certain changes should be made in the proposed settling tanks, provided an area of as much as 8 acres of filter beds should be constructed, instead of 6, as proposed.

On July 20, 1904, the Board received from your engineer a communication submitting plans showing a change in the location of the settling tanks; and the Board, after an examination of the plans of the proposed tanks as now arranged, finds that they are of adequate size and capacity for the present requirements of the works, and are so located that the liquid sludge in them can be discharged upon sludge beds built upon the low area of land adjacent to the brook and formerly used as a cranberry bog. By building sludge beds on this area, having an area of about 2 acres, as advised, with pipes for discharging such liquid matters from the settling tanks as will readily flow upon the sludge beds, the settling tanks can be emptied and cleaned as often as may be necessary for the removal

of as much of the solid matter as it is practicable to remove from these waste liquors before applying them to the filters.

With the modifications indicated, the Board is of the opinion that the plan of collecting these wastes, pumping them to settling tanks and discharging the effluent upon about 8 acres of filter beds, as proposed, is the best practicable means now available of rendering the waste and refuse from this tannery harmless and preventing the pollution of the Neponset River; and you are hereby notified to cease, on or before July 1, 1905, from discharging the sewage and manufacturing wastes from your factory into Hawes Brook as at present until these wastes have been rendered harmless, as required by the provisions of the act.

Pittsfield.

Nov. 3, 1904.

To the Board of Public Works of the City of Pittsfield.

Gentlemen: — This Board has received communications recently from Mr. James Fallon, who states that he is the owner of lands adjacent to the southerly side of the Pittsfield sewage-disposal area, claiming that his property is injured by drainage from the filter beds flowing upon the low lands near the river, and especially by scum blowing from the filter beds in summer. From an examination of the locality it appears to the Board that the complaint that scum of dried sludge blows from the filters over the land in question is well founded, since a considerable quantity of such matter was found upon the fields south of the filter beds. There are also indications that drainage from the filter beds finds its way to these lands. The Board brings the matter to your attention for such action as you may deem proper.

Rockland.

Sept. 1, 1904.

To the Board of Health of the Town of Rockland.

Gentlemen: — In response to your request for an examination of a locality in Rockland where difficulty has been experienced on account of the overflow of cesspools, and advice as to disposing of the sewage, the Board has caused the locality to be examined by one of its engineers.

It appears that the trouble experienced occurred in the neighborhood of the corner of Blanchard and Church streets, where the cellars of three houses have been flooded with polluted water apparently derived from a neighboring cesspool. It further appears that after stopping the leakage from a water pipe which was finding its way into a drain on Blanchard Street and apparently thence into the cesspool, the level of the water in the cesspool quickly lowered, and the water disappeared from the cellars of the dwellings which had been flooded.

It seems probable, from an examination of the locality, that the trouble complained of was caused largely by the water leaking into the cesspool

from the water pipe, and, the leak having been stopped, it seems unlikely that further similar difficulty will occur, though it is possible that an excessive quantity of water may find its way into the cesspool in very wet weather, unless a drain shall be provided to remove the ground water from its neighborhood.

It is evident, from an examination of the conditions in this region, as well as in other portions of the thickly settled area of Rockland, that a sewerage system is greatly needed, in order to avoid trouble such as that which has been complained of and to avoid the pollution of local water courses; and the Board would advise that the best method of preventing further trouble of this sort in the future will be to provide a sewerage system.

The Board would advise that a general system of sewerage for the town be planned first, and that the sewers that may be required be constructed in accordance with this plan as may be necessary from time to time.

Rutland (Industrial Camp for Prisoners).

July 21, 1904.

To the Board of Prison Commissioners, Mr. Frederick G. Pettigrove, *Chairman.*

Gentlemen: — The State Board of Health has considered the plan for the disposal of sewage at the temporary industrial camp for prisoners at Rutland, and has caused the locality to be examined by one of its engineers. The Board is informed that this camp will probably be used for a period of about ten years, and that about 125 persons will be connected with the sewerage system.

The plan provides for the collection of the sewage in a sewer 8 inches in diameter, in which it will be conveyed to a tank or reservoir, whence it will be discharged intermittently upon four filter beds, having an aggregate area of about 5,000 square feet, the effluent from which will find its way into the Ware River. A sludge bed is also provided for the disposal of sludge from the settling tank.

In the opinion of the Board, these plans will, if carried out as proposed, provide satisfactorily for the purification of the sewage of the camp at Rutland under the conditions proposed.

Salem.

May 5, 1904.

Hon. J. N. Peterson, *Mayor, Salem, Mass.*

Dear Sir: — In accordance with the request of Mr. E. W. Bowditch, engineer in charge of Salem sewerage, for information as to the capacity of the proposed trunk sewer of the city of Salem between the junction of Derby and Webb streets and the site of the proposed pumping station in Salem, the Board directs me to inform you that the plans of said sewer on file in this office, which were approved by this Board on Sept. 3, 1903, are,

in its opinion, of sufficient capacity for the present and prospective needs both of the city of Salem and the town of Peabody, should it be decided to dispose of the sewage and manufacturing wastes of both places through this proposed sewer.

AUG. 4, 1904.

To the Sewerage Commission of the City of Salem, Mr. REUBEN ABEY, *Secretary*.

GENTLEMEN: — The State Board of Health received from you on July 6, 1904, the following application for the approval of plans of a main sewer in Salem, under the provisions of chapter 353 of the Acts of the year 1901: —

In accordance with the provisions of Chapter 353 of the Acts of 1901, and by order of the Sewerage Commission of the City of Salem, I hereby respectfully petition your honorable Board for its approval of the Trunk Sewer from Derby St. in Salem to the Peabody line as shown upon plan herewith presented, entitled — Salem, Mass., Sewerage plan, showing location of Proposed North River Trunk Sewer, Scale 400 ft. to an inch; and profile sheets 1-2-3-4-5-6 entitled North River Trunk Sewer, Scales; horizontal 40 ft. to an inch, and vertical, 4 ft. to an inch; both plan and profiles date June 1904 and signed Ernest W. Bowditch, Chief Engineer.

Upon receipt of the application and plans, the Board gave notice of a hearing to be held at its office on July 21, 1904, by publication of the notice in three newspapers published in the city of Salem; and representatives of the city of Salem and the town of Peabody were present at the hearing.

The plans of the proposed sewer as modified and finally presented to the Board provide for a main sewer from the boundary line between the city of Salem and the town of Peabody at Harmony Grove Street, extending through the North River valley in Harmony Grove, Grove, Goodhue, Bridge and Webb streets, and along the south-westerly shore of Collins Cove to the head of the proposed main trunk sewer, which is to extend from Derby Street to the proposed pumping station near Cat Cove; the plan now submittted being a part of the system of sewage disposal for Salem and Peabody approved by the State Board of Health on Sept. 3, 1903, which is designed to dispose of all of the sewage of the city of Salem and the town of Peabody by discharging it into Salem harbor, at an outlet near Great Haste Island. The plan now submitted supersedes, however, that portion of the plan approved last year providing for a sewer from the junction of Pleasant and Webster streets in Salem to the head of the main trunk sewer in Derby Street, a change having been found desirable in the location of a part of this sewer.

The main sewer as now proposed from the boundary line between Salem and Peabody to Derby Street in Salem is of approximately the same capacity as that proposed by the State Board of Health, after an investigation of the requirements of Salem and Peabody in the matter of sewer-

age in the year 1896, though the upper end of the sewer is at a somewhat lower level than in the plan then proposed.

The State Board of Health, acting under the provisions of chapter 353 of the Acts of the year 1901, having given a hearing in accordance with the requirements of that act, hereby approves the plan and profile of the proposed trunk sewer as now submitted, which provide for a sewer as follows: beginning at Harmony Grove Street, at the boundary line between Salem and Peabody, with a diameter of 52 inches and an elevation of 7.61 feet above mean low water; thence running through Harmony Grove and Grove streets to the North River, at a grade of 1 in 1,500; crossing the North River by means of two lines of pipe, 36 inches in diameter, laid beneath the bottom of the river; thence through Grove to Goodhue Street, with a diameter of 52 inches and a grade of 1 in 1,500; thence through Goodhue and Bridge streets to North Street, with a diameter of 57 inches and a grade of 1 in 2,000; thence through Bridge Street, Webb Street and private land along the shore of Collins Cove to Derby Street, with a diameter of 60 inches and a grade of 1 in 2,000, the sewer at Derby Street being .67 of a foot above mean low water.

The plans bear the following titles: —

Plan: "Salem, Mass., sewerage. Plan showing location of proposed North River trunk sewer. Scale 400 feet to an inch. June 1904. Ernest W. Bowditch, Chief Engineer."

Profile: "Salem, Mass., sewerage. North River trunk sewer profile. Scales: Horizontal, 40 feet to an inch. Vertical, 4 feet to an inch. June 1904. Ernest W. Bowditch, Chief Engineer." (6 sheets, Nos. 1–6.)

The Board hereby certifies that the capacity of the main trunk sewer, as provided in the plans herein approved, is sufficient to discharge the sewage of the town of Peabody in addition to that naturally tributary to this sewer in the city of Salem, including such manufacturing wastes from both places as may reasonably be disposed of through this sewer.

Southborough (Deerfoot Farm Company).

May 5, 1904.

To the Deerfoot Farm Company, Southborough, Mass., Mr. Robert M. Burnett, *Treasurer.*

Gentlemen: — The State Board of Health has considered your proposed plans for the disposal and purification of the wastes of the works of the Deerfoot Farm Company at Southborough, designed to purify 25,000 gallons of washings from the dairy and slaughter house of the works, and has caused the locality to be examined by its engineer.

It appears, from information submitted by you, that the quantity of waste amounts to from 20,000 to 25,000 gallons per day in the winter season, and to less than 20,000 gallons per day in the summer; and that the wastes in the summer season are composed almost wholly of waste from the creamery, containing more or less milk, while in winter the creamery

waste is somewhat less than in summer; but, in addition to the creamery waste, there is a considerable quantity of waste from the slaughter house. It further appears that the creamery wastes consist of water used for washing purposes, and a little milk; but the Board is informed that most of the skimmed milk is now removed and discharged into the ground at some place where it is not objectionable. The wastes from the slaughter house consist chiefly of water used for washing.

The present method of disposal of the wastes is to discharge them upon fourteen small sand filter beds near the New York, New Haven & Hartford Railroad, north-west of the buildings. These beds appear to be well adapted for the purification of these wastes, and the purification appears to be satisfactory, but an objectionable odor is noticeable in the neighborhood of the beds.

The plan now proposed for the purification of these wastes provides for three settling tanks, a charcoal filter and a coke sludge filter to receive the solid matter which may accumulate in the tanks. The entire plant is to be enclosed within a building, which will include a compost table, where the material collected on the sludge filter will be mixed with coke or coal dust and burned beneath the boilers. The plans provide for three settling tanks, having a total capacity of 5,400 gallons; and, with all three tanks in use and the flow of sewage amounting to 25,000 gallons per day for ten hours, the sewage will be about two hours in passing through the settling tanks. These tanks are so arranged that one can be separated from the others while it is being cleaned.

From the settling tanks the sewage passes to a charcoal filter, and a flush tank is indicated on the plans, with the intention, apparently, of discharging sewage intermittently; but the details of the operation of this settling tank or of the method of applying sewage to the charcoal filters are not shown. The charcoal filter, as indicated on the plans, has an area of 21 square feet. With a flow of 25,000 gallons per day, the rate of filtration through this filter would be about 50,000,000 gallons per acre per day. The sludge filter indicated on the plans has an area of 42 square feet. Each of the tanks has a capacity of 240 cubic feet, and the whole contents of a tank would apparently be discharged upon the sludge filter each time it is emptied. This would be sufficient to flood the sludge filter to a depth of nearly 5 feet. The effluents from the sludge and charcoal filters are to be discharged upon the present sand filters.

In the opinion of the Board, the plan for purifying the wastes from your creamery in the manner indicated would be entirely inadequate for the purpose, and the Board does not advise its adoption.

On several occasions, when the present filters have been examined, it has been found that the sewage has been allowed to flow for long periods upon a small portion of the area. It appears to the Board probable that by applying the sewage to these beds properly they will purify the wastes

in a satisfactory manner. The flow of sewage should be changed from bed to bed in rotation, and an amount applied that shall make a depth not greater than 2 inches at any one time. The Board would advise that this method of operation be followed, and the results observed; and if the results should not then be satisfactory, the Board will, upon application, give you further advice as to the disposal of these wastes.

South Hadley.

April 28, 1904.

To the Committee on Sewers, South Hadley Falls, Mass., Mr. M. J. Moriarty, *Chairman.*

Gentlemen: — The State Board of Health received from you on April 11, 1904, a communication giving notice of your intention to use the stream known as Buttery Brook, which flows through the village of South Hadley, as a place of disposal for the sewage of the village, and requesting the advice of the Board thereon; and in response to this communication the Board has caused the locality to be examined by one of its engineers. The results of this examination show that at the present time one of the tributaries of Buttery Brook is greatly polluted by sewage from about 60 dwelling houses, and that below this tributary the main brook passes through the school grounds, where it receives additional sewage from about 700 pupils discharged through two outlets, one discharging directly into the brook, while the other discharges upon the ground a short distance from the bank. The stream and its surroundings in the densely populated part of the village are at present extremely foul and offensive.

The plan proposed as a remedy for the existing conditions provides for cleaning out and straightening the channel of the brook, which is now very crooked, and much obstructed by débris of various kinds, and thereafter using this channel as a main sewer for this neighborhood.

In the opinion of the Board, this plan is an extremely objectionable one, since the flow of the stream would be so small in the summer season that the proposed channel would be simply an open sewer; and the plan is not only objectionable from a sanitary point of view, but would, in the opinion of the Board, be a more expensive one for the disposal of the sewage of this neighborhood than a plan which would provide for the removal of the sewage in a properly constructed sewer to a suitable outlet into the Connecticut River.

Some of the outlets of sewers already constructed in the village are very serious nuisances and should be abolished. The most economical and satisfactory method of removing the very objectionable conditions now existing in the village of South Hadley will be to prepare first some general plan of sewerage which will provide for all of the thickly settled parts of the village. The sewers required for immediate use can then be constructed in such a way as to form part of this general system, which can be extended from time to time, as may be required. The plan should

be made under the direction of an engineer of experience in matters relating to sewerage and sewage disposal; and when the plan has been prepared, the Board will, upon application, give you further advice relative to the sewerage of the town.

WAKEFIELD.

JUNE 15, 1904.

To the Board of Sewer Commissioners of the Town of Wakefield, MR. WM. B. DANIEL, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on May 14, 1904, the following application for the approval of a proposed sewer in Richardson Street, being an extension of the system already approved by this Board: —

> The town of Wakefield, through its sewer commissioners, requests the approval by your Board of the accompanying plan and profile of a proposed sewer in Richardson Street; said sewer will be an extension of the system which has been approved by your Board.

A sewer in Richardson Street was shown on the plan of sewerage approved by this Board in February, 1901, after a hearing, and the plan now presented is a slight modification of the plan presented at that time.

The Board hereby approves the plan of the proposed sewer in Richardson Street as now submitted.

WEST SPRINGFIELD.

MARCH 3, 1904.

To the Board of Selectmen of the Town of West Springfield.

GENTLEMEN: — The State Board of Health received from you on Feb. 10, 1904, an application for advice with reference to a proposed sewer for the removal of sewage and storm water from a district in the northerly part of West Springfield, in which your proposed plan is described as follows: —

> The sewer is to provide for sewage and storm water from the cemetery on Riverdale Street, north of Ashley Avenue, to a point near the north side of Bagg Brook; also from the Country Club northerly to the same point, north of Bagg Brook; thence across private land to the Connecticut River, emptying into the same at the mouth of Bagg Brook. The outlet consists of a small submerged pipe with an overflow outlet, the submerged pipe passing out about fifty (50) feet into the river and the end turned upward and down stream at an angle of about forty-five (45) degrees.

The application is accompanied by a plan of the proposed sewer and outlet. The sewer is about a mile in length in Riverdale Street, and is designed to receive the sewage from houses along the street and to remove the storm water collected upon the street to an outlet into the Connecticut River, so arranged that at times of storm the mingled sewage and storm

water will discharge near the bank of the river, while the ordinary flow of sewage will be conveyed to an outlet located 50 feet from the river bank at low water.

The area from which storm water is likely to be discharged into the proposed sewer is not indicated, and the Board is unable to advise you as to whether the capacity is sufficient for the removal of storm water from the area which this sewer is designed to serve.

If the outlet is arranged as proposed so that the dry-weather flow of sewage will be discharged into the river 50 feet from the shore at low water, allowing a part of the flow at times of storm to discharge at the proposed overflow near the river bank, the disposal of the sewage is not likely to cause objectionable conditions in the neighborhood. The Board would advise that the possible need of separating the sewage from the storm water in this district at some future time be taken into consideration in the construction of sewers and house connections.

Pollution of Ponds, Streams and Other Bodies of Water.

The following is the substance of the action of the Board during 1904 in reply to applications for advice relative to the pollution of ponds, streams and other bodies of water: —

Canton (Neponset Woolen Mills).

Feb. 4, 1904.

To the Neponset Woolen Mills, Canton Junction, Mass.

Gentlemen: — In a communication dated Oct. 2, 1903, stating that you had received notice to discontinue the pollution of the Neponset River, you make the following statement: —

> The water diverted from that river by us for power and manufacturing processes is carried through a separate channel for three-quarters of a mile before being put into the river again. This channel is as broad as the river bed, and efficiently cleanses the water from everything objectionable before joining the Neponset River.

After receiving this communication, the Board caused examinations of your factory and the processes carried on therein to be made by one of its engineers, and samples of the wastes from the various processes carried on in the factory and from the canal, both above and below your factory and just above the point where it joins the Neponset River, to be collected for analysis. The results of these examinations and analyses show that all of the sewage of 90 operatives is discharged directly into the canal; that dust from shoddy picking machines is blown into the stream by a fan blast, and is to be seen at nearly all times floating on the surface of the water; and that polluted water which has been used in the washing and dyeing of cloth is discharged into the stream.

The results of the analyses show that the quantity of organic matter present in the water of the channel immediately below your mill is much greater than above, and that the water at the lower end of the channel where it joins the Neponset River is more polluted than the water above your mill. The examinations show clearly that the Neponset River is being polluted by sewage and manufacturing waste from your mill.

Leicester.

April 7, 1904.

To the Selectmen and Overseers of the Poor, Leicester, Mass.

Gentlemen: — You are hereby notified that the results of examinations made by this Board of the effluent from the sewage filters of the Leicester Poor Farm show that imperfectly purified sewage finds its way from these filters into the water supply of the city of Worcester, and that the disposal of the sewage of the Poor Farm, in the manner in which it is being carried on, is a serious menace to the health of the people of that city, and contrary to the provisions of chapter 75 of the Revised Laws of Massachusetts.

The filters now in use evidently fail to properly purify the sewage. If all of the effluent from the present filters should be collected and applied to other filters properly constructed and operated, it is probable that the efficient purification of the sewage could be effected at all times. It may also be practicable to purify this sewage efficiently by pumping it to the gravelly lands north-east of the Poor Farm, and disposing of it on filters located at a place where the sewage would percolate for a sufficient distance through the ground to become thoroughly purified before entering the water course.

New Bedford.

July 21, 1904.

To the Board of Health of the City of New Bedford.

Gentlemen: — In response to your application for advice as to the taking of quahaugs from the bed of the Acushnet River, to be sold as food, the State Board of Health has examined the conditions prevailing about the city of New Bedford and the places from which shellfish are collected, and has made numerous bacterial examinations of shellfish collected from the flats and tidal waters about the city.

This matter was first brought to the attention of the Board about three years ago, and since that time the Board has made investigations as to the effect of the discharge of sewage into flats and tidal waters upon the shellfish contained therein, and also as to the means for determining whether shellfish are injuriously affected by such pollution, and whether they are liable to injure the health of those who may use them as food, either raw or cooked.

The results of these investigations show that shellfish taken from waters polluted by sewage contain the bacteria found in sewage, and are liable to injure the health of those who may use them as food.

The sewage from about two-thirds of the city of New Bedford is discharged directly into New Bedford harbor through twenty-six sewer outlets, and the sewage from the remaining part of the city is discharged into Clark's Cove through about six outlets. The great bulk of the shellfish collected at New Bedford are taken from New Bedford harbor, and observations by the Board show that a large proportion of them are collected on the New Bedford side of the river, often within 400 feet of the shore. Samples of quahaugs, collected from all over the harbor by those who make it a business to collect them for sale, have been analyzed by the Board, and a large proportion have been found to show the presence of sewage bacteria.

In Clark's Cove the observations show that quahaugs are taken all about the upper end of the cove, and examinations of samples of quahaugs taken at different times from this locality by those who make a business of collecting these shellfish for sale have shown that a large percentage of them contain sewage bacteria, evidently derived from the sewage discharged into the cove.

Under the circumstances the Board is of the opinion that shellfish taken from New Bedford harbor and from Clark's Cove are liable to injure the health of those who may use them, and that the further taking of shellfish from these waters under present conditions should be prevented. The Board has therefore brought the matter to the attention of the Commissioners on Inland Fisheries and Game, and has requested the commission to prohibit the taking of shellfish from the waters of New Bedford harbor north of or inside of a line drawn from Fort Point in Fairhaven to a point on the easterly shore of Clark's Point, one mile south of the most southerly sewer outlet in the city of New Bedford, or from the waters of Clark's Cove at any place within three-quarters of a mile of the outlet of any sewer of the city of New Bedford discharging into Clark's Cove.

Plymouth.

March 3, 1904.

To the Board of Health of the Town of Plymouth, J. Holbrook Shaw, M.D., *Chairman.*

Gentlemen: — The State Board of Health has considered your communication, received October 24, relative to the pollution of the water of Eel River in Plymouth by waste products from a rubber factory, in which you request the Board to make an examination of the pollution of the river by these wastes; and in accordance with this request the Board caused the locality to be examined by one of its engineers and a sample of the water of the river to be analyzed.

As a result of the examination, it appeared that a considerable quantity of acid was used in the factory, and that wastes containing organic matter from the processes employed were discharged into the stream. These wastes did not, however, have a very noticeable effect upon the stream at

the time this examination was made, and a chemical analysis of a sample of water collected from the river below the works did not show that the water was being seriously polluted. It is possible that the quantity of wastes discharged may be greater at other times, or that in dry weather, when the flow of the stream is small, the stream or its banks may be affected by these waste matters to such an extent as to cause complaint on account of an objectionable appearance or odor.

It is understood that you desire a report at the present time, and the Board presents such information as it has thus far obtained in this matter. The Board will, if you so request, make a further examination of the stream during the coming summer, if its condition again becomes objectionable.

Quincy.

June 2, 1904.

To the Board of Health of the City of Quincy, Dr. Thomas J. Dion, *Secretary*.

Gentlemen: — In response to your request of May 16 for an examination of the condition of Furnace Brook, and advice as to the removal of the objectionable conditions in a portion of this valley, the Board has caused the locality to be examined by one of its engineers.

It appears that the objectionable conditions now complained of are the pollution of the brook and the flooding of cellars in a portion of the valley of this brook, especially in the neighborhood of Cross Street and Furnace Avenue. The waters of the brook have evidently risen higher than usual recently, on account of the caving in of a wall a short distance down stream from this district at a time of exceptionally heavy rain; and the cause of the objectionable conditions existing recently has been in part removed by the removal of this obstruction from the brook. The conditions could, however, be greatly improved by preventing the pollution of the brook in this region, and by lowering its bed and straightening its course.

The Board would suggest that it has been found of advantage by many cities, after reaching the size of Quincy, to take and control the brooks and other main lines of drainage, and to maintain them in such condition as to provide for the ready removal of surface water, and prevent their pollution.

Swampscott.

Oct. 6, 1904.

To the Metropolitan Park Commission, 14 Beacon Street, Boston, Mass.

Gentlemen: — Your communication of September 26 is received, calling attention to an objectionable condition existing at several of the coves along the north shore, especially at King's Beach in Swampscott, where you state that considerable quantities of seaweed have come in, which have been removed by your commission, but that complaints have been received since it was removed that the odors still persist. A communication to your board is also submitted, alleging the pollution of the beach

by the discharge of the sewage of Swampscott at Dread Ledge as the cause of the objectionable condition complained of.

The Board has caused an examination of the locality to be made, and finds that at the present time there is a very large deposit of a fibrous plant or seaweed upon the northerly part of King's Beach, north of the outlet of Stacey's Brook. This deposit is greatest at the present time at about high-water level, where the depth of the material is about 6 inches for a width of 10 feet or more; but there is a large quantity above the present level of high tides, evidently deposited there at the time of the previous high course of tides; and the entire width of the beach between high and low water is nearly covered with a layer of this matter, from 1 inch to 2 inches in depth, and a considerable quantity was seen in the water off the shore. The portions above high tide were evidently decomposing, and in places were covered with great numbers of small worms or maggots. The odor of the organic matter deposited between high and low water was not objectionable, resembling the odor of certain shellfish; but the decaying material above the level of high water had an offensive odor. The odor from this material has been less objectionable during the recent cool weather, judging from the information available to the Board, than it is in hot weather; and, at the time the examination was made, the most noticeably objectionable odors were those coming from the carcasses of three dead animals, the largest weighing perhaps 50 pounds.

The organism which has come up on the beach in such great quantities recently evidently grows off the shore, and becomes detached in greater quantities in some seasons than in others.

It is entirely improbable, in the opinion of the Board, that the discharge of the sewage of Swampscott at Dread Ledge has anything to do with the growth of this organism; and there is no evidence whatever that any sewage from that outlet comes upon this beach, the only sewage reaching there being a very small quantity which finds its way into Stacey's Brook in Lynn and Swampscott.

Similar objectionable conditions caused by seaweeds of various kinds have been produced at other places, but the troubles usually have been serious only at infrequent intervals.

The objectionable conditions now complained of could probably be greatly relieved by the removal of the material deposited on the beach by spring tides and tides higher than the average.

Wellesley.

Sept. 14, 1904.

To the Board of Health of the Town of Wellesley, Mr. J. Allen Tailby, *Secretary*.

Gentlemen: — In response to your request of August 1 for an examination of the water of Lake Waban in Wellesley, relative to its pollution by wastes from a paint mill, and advice as to the conditions found there, the

Board has caused the locality to be examined and samples of the water of the lake to be analyzed. From this examination it appears that tanks have been put in at the mill, into which the portion of the wastes resulting from the manufacture of green paint is discharged, and in this way a considerable quantity of lead formerly wasted into the pond recovered; but only about one-third of the wastes are discharged into these tanks, the remainder still being allowed to flow into the brook and thence into Lake Waban.

The results of the analyses of the water of the lake show that the quantity of lead present is about the same as at the time the previous examination was made, showing no improvement as yet since the tanks were introduced.

The information furnished to the Board as to the operation of the present tanks indicates that much lead can be removed from the wastes by passing them through tanks, and much valuable material secured; but it is essential, in order to secure the best results from this treatment, to provide sufficient tank capacity for the treatment of all of the wastes which are polluting the lake, instead of treating only a portion of them, as at present.

WINCHESTER.

OCT. 18, 190

To the Board of Health of the Town of Winchester, MR. JAMES HINDS, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on Sept. 14, 1904, a communication requesting the Board to take some action relative to a nuisance caused by Russel Brook in Winchester, in which you state: —

> We desire hereby to formally complain to the State Board of Health of the dangerous nuisance existing in Winchester, caused by the pollution of Russel Brook by sundry parties in Woburn allowing their sewage, consisting of decomposing fleshings and vat refuse, the odor from which is beyond description, to therein drain. Complaints from people abutting on the brook have been numerous and justifiable to this board, that the conditions resulting are unbearable, and a direct menace, in the opinion of this board, to their health and that of the entire community.

In response to your request, the Board has caused the locality to be examined by its engineer and samples of the water of the stream collected at several points in Woburn and Winchester to be analyzed.

The results of the examinations show that the brook receives foul wastes from the Robertson tannery on Eastern Avenue, that other polluting matters are evidently discharged into it by tanneries located between Prospect Street and John Street in Woburn, and that the stream where it enters Winchester was badly polluted and had a very foul odor at the time this examination was made, on September 27.

The liquid wastes from the various tanneries which now pollute the stream can be kept out of the stream and disposed of by discharging them

into the sewers, which were designed for the removal of these wastes as well as for the domestic sewage of this region.

In the opinion of the State Board of Health, the nuisance of which you complain can be prevented by action of the Woburn board of health under existing laws, and the attention of that board has been called to the results of the investigation of September 27.

WOBURN.

OCT. 18, 1904.

To the Board of Health of the City of Woburn.

GENTLEMEN: — Complaint having been made to the State Board of Health of a nuisance existing in Winchester near the boundary line between Winchester and Woburn, caused by the pollution of Russel Brook, the Board has caused the stream to be examined and samples of its waters to be analyzed.

The results of the analyses show that the water is very badly polluted, and when examined the odor in the neighborhood of the brook near the place where it crosses the boundary between Woburn and Winchester was very offensive. An examination shows that wastes from the Robertson tannery, so called, on Eastern Avenue in Woburn, and wastes from tanneries located between Prospect Street and John Street, in Woburn, find their way into the stream; and the offensive conditions complained of are evidently caused chiefly by the pollution of the stream by these wastes.

In the opinion of the State Board of Health, your Board has power under the existing laws to prevent the nuisance now existing, as a result of the discharge of tannery wastes into Russel Brook; and the Board brings the matter to your attention, in order that you may take such action as may be necessary.

The liquid wastes from the Robertson tannery can be disposed of into the existing sewerage system by extending the sewers; and the wastes from the remaining tanneries which now pollute Russel Brook can be collected and discharged into the sewers which pass through or near these works. Some preliminary treatment of the wastes will probably be required, to prevent the entrance into the sewers of matters which might interfere with their operation.

WORCESTER.

OCT. 6, 1904.

To Messrs. EDWIN P. CRERIE, ALBERT E. NEEDHAM, WILLIAM F. ROSS and Others, Residents of Lake View, Worcester.

GENTLEMEN: — The State Board of Health has considered your petition of Sept. 17, 1904, requesting that steps be taken whereby the sewage of the insane hospital on Belmont Street, Worcester, may be disposed of without discharging it into Lake Quinsigamond, and has caused the locality to be examined by one of its engineers. It appears from this examination

that the sewage of the Worcester Insane Hospital is discharged upon the lands east of the hospital, where a portion of it is used for the irrigation of crops and the remainder allowed to flow into pits or collect in pools, whence a portion of it evidently overflows at times of rain into Lake Quinsigamond, as stated in your petition.

The present method of disposing of the sewage creates a serious nuisance, besides polluting the lake. The examinations of the Board indicate that it is practicable to dispose of this sewage in a satisfactory manner, and prevent the objectionable conditions that now exist; and the Board will bring the matter to the attention of the hospital authorities.

Worcester (Worcester Insane Hospital).

Oct. 6, 1904.

To the Trustees of the Worcester Insane Hospital, Worcester, Mass.

Gentlemen: — The attention of the State Board of Health has been called to the discharge of sewage from the hospital into Lake Quinsigamond, and upon examination the Board finds that the sewage of the institution is used in part for the irrigation of crops, and that a large portion of it is discharged into pits or pools, where it accumulates to a depth of several feet, putrefies, and gives off a very offensive odor, creating a serious nuisance in the neighborhood, besides causing the pollution of the lake by the overflow from these pits.

The soil within the grounds of the hospital in this region appears to be coarse and porous, and well adapted to the purification of sewage by intermittent filtration; and there is very little doubt that filter beds could be constructed upon the hospital grounds at a reasonable expense, which would purify satisfactorily all of the sewage of the hospital and prevent the existing nuisance and the further pollution of the lake.

The Board would advise that you cause an investigation to be made, to determine the best practicable location for filter beds, and that plans be prepared for a sufficient area of filters to purify efficiently all of the sewage of the institution. It is advisable, in making the investigations and preparing plans, that you secure the assistance of an engineer of experience in matters relating to sewage disposal.

When investigations have been made and plans prepared, the Board will, upon application, give you further advice as to the disposal of the sewage.

EXAMINATION OF PUBLIC WATER SUPPLIES.

EXAMINATION OF PUBLIC WATER SUPPLIES.

The examination of public water supplies in Massachusetts was begun in the year 1887, under the provisions of chapter 274 of the Acts of the year 1886, entitled "An Act to protect the Purity of Inland Waters," and has been carried on to the present time under the provisions of that and subsequent laws. Each of the sources of water supply in the State has been examined from time to time to note changes in its physical condition, and chemical analyses of the waters of the various sources have been made, usually about once a month, supplemented by biological examinations of the waters of surface sources, and occasionally by determinations of the number of bacteria in both the surface and ground water sources. Information has been collected also as to temperature, rainfall, flow of streams, and such other matters as might affect the quality of the waters of the various sources. The work has been carried on under the direction of the chief engineer of the Board, the chemical and biological examinations being made at the laboratory for water analysis by the chemist of the Board.

The results of the earlier of these examinations were published in a special report of the Board on the examination of water supplies in 1890, and results of examinations made in subsequent years have been published in the annual reports. In the present report the results of the chemical analyses of the various sources are presented in tables and summaries so arranged as to afford a means of comparing the various waters with respect to color, organic matter, hardness, and the other properties usually considered in determining the quality of a water used for drinking; and a summary of the population within the watershed of each surface-water source is also presented. In order to show more nearly the average character of the various waters, the average of all of the analyses of the past five years has been used in making the tables.

At the end of the year 1904 all of the 33 cities in Massachusetts and 147 of the 320 towns were provided with public water supplies. This list includes all the places in the State having, according to the census of 1900, a population in excess of 6,000; and there are only 9 towns in the State which have a population in excess of 3,000 which are not provided with public water supplies. The total population, according to the census

of 1900, of the cities and towns provided with public water supplies is 2,590,037, while the population of those towns not having water supplies is 215,309.

While there are considerable areas in nearly all of the cities and towns in which the public water supply is not available, these areas are sparsely populated; and the number of people to whom the public water supply is not available in cities and towns having public water supplies is small. In addition to the cities and towns having public water supplies, there are cases in which a portion of the inhabitants of a town or village are supplied with water from some common source, generally a spring or well upon a neighboring hillside, the water of which is delivered in the houses through very small pipes, and a few towns in which the number of inhabitants supplied from such sources forms a large proportion of the whole population have been included in the list of cities and towns having public water supplies, though the analyses of the waters supplied to these places are omitted. There are also cases in which owners of factories and mills have private water supplies, used chiefly for protection against fire, but also to supply water for domestic purposes to buildings and tenements in the neighborhood, and those towns in which the population supplied in this way forms an important part of the whole have been included also.

Outside the areas provided with public water supplies and the places supplied with water from mills, etc., the sources of water supply of the inhabitants of the State are chiefly wells, located in the immediate neighborhood of the owner's dwelling. In many of the cities and larger towns spring waters are sold for drinking purposes, in packages of generally from one to five gallons. The spring-water sources were examined by the Board in 1900, and for the results of this examination reference is made to the report of that year.

The following table gives a list of the cities and towns having public water supplies which are available in the whole or in an important part of their territories, with the population of each, the date of introduction of works, the ownership of the works, and the source or sources of water supply at the present time: —

TABLE No. 1.

City or Town.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Metropolitan Water District.*	830,709	-	- -	Wachusett Reservoir on south branch of Nashua River, Clinton. Framingham Reservoir No. 2 on Sudbury River, Framingham. Reservoirs on tributaries of Sudbury River, as follows: Sudbury Reservoir on Stony Brook, Southborough, which receives water from Wachusett Reservoir; Framingham Reservoir No. 3 on Stony Brook, Framingham, which receives water from Sudbury Reservoir; Hopkinton Reservoir on Indian Brook, Hopkinton; Ashland Reservoir on Cold Spring Brook, Ashland. Lake Cochituate, Wayland and Natick.
Arlington, . .	8,603	1872	Town, . .	
Belmont, . . .	3,929	1887	Town, . .	
Boston, . . .	560,892	1848	City, . .	
Chelsea, . . .	34,072	1867	City, . .	
Everett, . . .	24,336	1867	City, . .	
Lexington, . .	3,831	1884	Town, . .	
Malden, . . .	33,664	1870	City, . .	
Medford, . . .	18,244	1870	City, . .	
Melrose, . . .	12,962	1870	City, . .	
Milton, . .	6,578	1885	Town, . .	
Nahant, . . .	1,152	1885	Town, . .	
Quincy, . . .	23,899	1884	City, . .	
Revere, . . .	10,395	1884	Private,† .	
Somerville, . .	61,643	1867	City, . .	
Stoneham, . .	6,197	1883	Town, . .	
Swampscott, . .	4,548	1885	Town, . .	
Watertown, . .	9,706	1885	Town, . .	
Winthrop, . .	6,058	1884	Private,‡ .	
Abington, . . .	4,489	1887	Town, . .	Big Sandy Pond, Pembroke.
Rockland, . .	5,327	1887	Town, . .	
Adams, . . .	11,134	1874	Fire district,	Bassett Brook; Dry Brook, Cheshire; tubular wells near Hoosick River, Cheshire.
Agawam, . . .	2,536	1877	Private, .	Springs.
Amesbury, . . .	9,473	1885	Private,‡ .	Two systems tubular wells.
Amherst, . . .	5,028	1880	Private, .	Amethyst Brook, Pelham, on which there is a storage reservoir; spring in Pelham.
Andover, . . .	6,813	1890	Town, . .	Haggett's Pond.
Arlington, . . .	-	-	- -	See Metropolitan Water District.
Ashburnham, . .	1,882	1870	Town, . .	Storage reservoir.
Ashfield, . . .	955	1904	Private, .	Bear Swamp Brook.
Athol, ...	7,061	1875	Private,† .	Storage reservoir in Phillipston; storage reservoir on Buckman Brook.
Attleborough, . .	11,335	1873	Town, . .	Large well near Seven Mile River.
Avon, ...	1,741	1890	Town, . .	Large well.
Ayer, ...	2,446	1887	Town, . .	Large well.
Barre, ...	2,059	1895	Private, .	Storage reservoir.
Belmont, . . .	-	-	- -	See Metropolitan Water District.

* This district was established by act of the Legislature in 1895. The dates of introduction of water in the cities and towns of the district are the dates of completion of the earlier works.
† Works of water company taken by town early in 1905. ‡ Town has voted to take works (1905).

TABLE NO. 1 — *Continued.*

City or Town.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Beverly,	-	-	- -	See Salem.
Billerica,	2,775	1898	Town,	Tubular wells near Concord River.
Boston,	-	-	- -	See Metropolitan Water District.
Braintree,	5,981	1887	Town,	Filter-gallery and tubular wells near Little Pond; Great Pond (used also by Randolph and Holbrook).
Bridgewater,	5,806	1888	Private,	Tubular wells and large wells near Town River.
East Bridgewater,	3,025	1888	Private,	
Brockton,	40,063	1880	City,	Silver Lake, Pembroke; storage reservoir on Salisbury Brook.
Whitman,	6,155	1883	Town,	
Brookfield,	3,062	1889	Town,	Storage reservoir; Seven Mile River.
Brookline,	19,935	1875	Town,	Tubular wells and filter-gallery near Charles River.
Cambridge,	91,886	1856	City,	Storage reservoir on Stony Brook, Waltham and Weston; storage reservoirs on Hobbs Brook, Waltham, Lincoln and Lexington; Fresh Pond.
Canton,	4,584	1889	Town,	Large well and tubular wells at Springdale; large well at Henry's Spring, Stoughton.
Chelsea,	-	-	- -	See Metropolitan Water District.
Cheshire,	1,221	1876	Private,	Thunder Brook; Kitchen Brook.
Chester,	1,450	1898	Fire district,	Austin Brook.
Chicopee,	19,167	1845	City,	Morton Brook; Cooley Brook; Dingle Brook Reservoir.
Clinton,	13,667	1882	Town,	Lynde's Pond, Sterling; Spring Basin, Sterling; Heywood Brook, Sterling.
Lancaster,	2,478	1885	Town,	
Cohasset,	2,759	1886	Private,	Two systems tubular wells; filter-gallery near Lily Pond.
Colrain,	1,749	1902	Fire district,	Mountain Brook.
Concord,	5,652	1873	Town,	Sandy Pond, Lincoln.
Lincoln,	1,127	1874	Town,	
Cottage City,	1,100	1890	Private,	Springs.
Dalton,	3,014	1884	Fire district,	Storage reservoir on Egypt Brook.
Danvers,	8,542	1876	Town,	Middleton Pond, Middleton.
Middleton,	839	1876	Town,	
Dedham,	7,457	1881	Private,	Large well and tubular wells near Charles River.
Deerfield,	1,969	1903	Water supply district.	Roaring Brook, Whately.
Dracut,	3,253	1900	Private,	Tubular wells near Beaver Brook.
East Bridgewater,	-	-	- -	See Bridgewater.
Easthampton,	5,603	1870	Town,	Bassett Brook.
Easton,	4,837	1887	Village district.	Large well.
Erving,	-	-	- -	See Montague.
Everett,	-	-	- -	See Metropolitan Water District.
Fairhaven,	3,567	1894	Private,	Tubular wells near Nasketucket River.

TABLE No. 1 — *Continued.*

City or Town.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Fall River,	104,863	1874	City,	North Watuppa Lake.
Falmouth,	3,500	1899	Town,	Long Pond.
Fitchburg,	31,531	1872	City,	Scott Reservoir; Falulah Reservoir; Meetinghouse Pond, Westminster.
Foxborough,	3,266	1891	Water supply district.	Tubular wells.
Framingham,	11,302	1885	Private,*	Filter-gallery near Farm Pond.
Franklin,	5,017	1884	Private,	Large wells near Mill Brook; Beaver Pond.
Gardner,	10,813	1882	Town,	Crystal Lake.
Gill,	1,015	1888	Private,	Spring.
Gloucester,	26,121	1885	City,	Dike's Brook Reservoir; Haskell Brook Reservoir; Wallace Reservoir.
Grafton,	4,869	1886	Private,	Large well near Quinsigamond River.
Great Barrington,	5,854	1867	Fire district,	East Mountain Reservoir; Green River.
Greenfield,	7,927	1870	Fire district,	Storage reservoir on Glen Brook, Leyden; Green River.
Groton,	2,052	1897	Private,	Large well near Baddacook Pond.
Hardwick,	3,208	–	Private,	Springs.
Hatfield,	1,500	1896	Town,	Storage reservoir on Running Gutter Brook.
Haverhill,	37,175	1802	City,	Crystal Lake; Pentucket Lake; Kenoza Lake; Johnson's Pond; Millvale Reservoir.
Hingham,	5,059	1880	Private,	Accord Pond; large well near Fulling Mill Pond.
Hull,	1,703	1882	Private,	Accord Pond; large well near Fulling Mill Pond.
Hinsdale,	1,485	1889	Fire district,	Storage reservoir.
Holbrook,	–	–	– –	See Randolph.
Holliston,	2,598	1891	Private,	Large well.
Holyoke,	45,712	1873	City,	Manhan River, Southampton; Wright and Ashley Pond; high-service reservoir; Whiting Street Reservoir, Northampton.
Hopedale,	–	–	– –	See Milford.
Hopkinton,	2,623	1884	Town,	Tubular wells.
Hudson,	5,454	1884	Town,	Gates Pond, Berlin.
Hull,	–	–	– –	See Hingham.
Huntington,	1,475	1899	Fire district,	Cold Brook, Blandford.
Hyde Park,	13,244	1885	Private,	Tubular wells near Neponset River; tubular wells near Mother Brook, Dedham.
Ipswich,	4,658	1894	Town,	Storage reservoir on Dow's Brook.
Kingston,	1,955	1886	Town,	Large well near Jones River; tubular wells.
Lancaster,	–	–	– –	See Clinton.
Lawrence,	62,559	1875	City,	Merrimack River, filtered.
Lee,	3,596	1881	Private,	Codding Brook, on which is a storage reservoir; Basin Pond Brook.
Leicester,	3,416	1891	Water supply district.	Large wells.
Lenox,	2,942	1875	Private,	Storage reservoir; Yokun River.

* Town has voted to take works (1905).

TABLE NO. 1 — *Continued.*

City or Town.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Leominster, . .	12,392	1873	Town, . .	Haynes Reservoir; Morse Reservoir; Fall Brook Reservoir.
Lexington, . . .	-	-	- -	See Metropolitan Water District.
Lincoln, . . .	-	-	- -	See Concord.
Longmeadow, . .	811	1895	Town, . .	Cooley Brook.
Lowell, . . .	94,969	1872	City, . .	Tubular wells near Merrimack River.
Ludlow, . . .	-	-	- -	See Springfield.
Lynn, ...	68,513	1871	City, . .	Birch Reservoir, Lynn and Saugus; Breed's Reservoir; Walden Reservoir, Lynn and Saugus; Glen Lewis Reservoir; Hawkes Reservoir, Lynn and Saugus; Saugus River, Saugus.
Saugus, . . .	5,084	1878	Town, . .	
Malden, . . .	-	-	- -	See Metropolitan Water District.
Manchester, . .	2,522	1892	Town, . .	Large well and tubular wells near Saw Mill Brook.
Mansfield, . . .	4,006	1888	Water supply district.	Large well near Pecuanticiot River.
Marblehead, . .	7,582	1885	Town, . .	Two large wells.
Marlborough, . .	13,609	1883	City, . .	Lake Williams; storage reservoir on Millham Brook.
Marshfield, . . .	1,810	1890	Private, .	Large well.
Maynard, . . .	3,142	1889	Town, . .	White Pond.
Medfield, . . .	2,926	-	Private, .	Spring.
Medford, . . .	-	-	- -	See Metropolitan Water District.
Melrose, . . .	-	-	- -	See Metropolitan Water District.
Merrimac, . . .	2,131	1904	Town, . .	Tubular wells near Kimball's Pond.
Methuen, . . .	7,512	1875	Town, . .	Tubular wells near Spicket River.
Middleborough, . .	6,885	1885	Fire district,	Large well near Nemasket River.
Middleton, . . .	-	-	- -	See Danvers.
Milford, . . .	11,376	1881	Private, .	Charles River, filtered. Large wells.
Hopedale, . .	2,087	1881	Private, .	
Millbury, . . .	4,460	1895	Private, .	Large well.
Millis, ...	1,053	1891	Town, . .	Spring.
Milton, . . .	-	-	- -	See Metropolitan Water District.
Monson, . . .	3,402	1895	Town, . .	Large well.
Montague, . . .	6,150	1887	Fire district,	Lake Pleasant.
Erving, . . .	973	-	Fire district,	
Nahant, . . .	-	-	- -	See Metropolitan Water District.
Nantucket, . . .	3,006	1878	Private, .	Wannacomet Pond; wells near pond.
Natick, . . .	9,488	1874	Town, . .	Tubular wells near Lake Cochituate.
Needham, . . .	4,016	1890	Town, . .	Large wells; tubular wells.
New Bedford, . .	62,442	1869	City, . .	Great Quittacas Pond, Lakeville; Little Quittacas Pond, Lakeville; storage reservoir on Acushnet River, Acushnet.

TABLE No. 1 — *Continued.*

City or Town.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Newburyport,	14,478	1881	City,	Large wells; spring.
Newton,	33,587	1876	City,	Filter-gallery and tubular wells near Charles River, Needham.
North Adams,	24,200	1861	City,	Storage reservoir on Notch Brook; Broad Brook, Pownal, Vt.
Northampton,	18,643	1871	City,	Storage reservoir on Roberts' Meadow Brook; West Brook; Mountain Street Reservoir.
North Andover,	4,243	1898	Town,	Great Pond.
North Attleborough,	7,253	1884	Town,	Large well near Ten Mile River.
Northborough,	2,164	1882	Town,	Storage reservoir on Cold Harbor Brook, Boylston and Shrewsbury.
Northbridge,	7,036	1889	Private,	Storage reservoir on Cook Allen Brook, Sutton; springs.
North Brookfield,	4,587	1898	Town,	Doane Pond; North Pond.
Northfield,	1,966	1900	Private,	Storage reservoir.
Norwood,	5,480	1885	Town,	Buckmaster Pond, Westwood.
Orange,	5,520	1878	Town,	Spring; Coolidge Brook.
Palmer,	7,801	1886	Private,	Storage reservoir.
Peabody,	11,523	1799	Town,	Brown's Pond; Spring Pond, Lynn, Salem and Peabody.
Pittsfield,	21,766	1855	City,	Ashley Lake, Washington; Ashley Brook, Washington; Sacket Brook, Dalton; Hathaway Brook, Dalton; Mill Brook, Washington.
Plymouth,	9,592	1855	Town,	Little South Pond; Great South Pond; Lout Pond.
Provincetown,	4,247	1893	Town,	Large well.
Quincy,	-	-	- -	See Metropolitan Water District.
Randolph,	3,993	1888	Town,	Great Pond, Randolph and Braintree (used also by Braintree).
Holbrook,	2,229	1888	Town,	
Reading,	4,969	1891	Town,	Filter-gallery near Ipswich River.
Revere,	-	-	- -	See Metropolitan Water District.
Rockland,	-	-	- -	See Abington.
Rockport,	4,592	1895	Town,	Cape Pond.
Rutland,	1,334	1896	Town,	Muschopauge Lake.
Salem,	35,956	1868	City,	Wenham Lake, Beverly and Wenham: Longham Reservoir, Beverly and Wenham.
Beverly,	13,884	1868	City,	
Saugus,	-	-	- -	See Lynn.
Scituate,	2,470	1901	Private,	Tubular wells.
Sharon,	2,060	1885	Town,	Large well; tubular wells near Beaver Brook.
Sheffield,	1,804	1897	Private,	Springs.
Shelburne,	1,508	1885	Private,	Springs.
Shirley,	1,680	1903	Town,	Large well.
Somerville,	-	-	- -	See Metropolitan Water District.
Southbridge,	10,025	1880	Private,	Storage reservoir on Hatchet Brook; two reservoirs on small brook.

TABLE NO. 1 — *Continued.*

CITY OR TOWN.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
South Hadley,	4,526	1872	Fire district,	Storage Reservoir on Buttery Brook; storage reservoir on Leaping Well Brook.
Spencer,	7,627	1883	Town,	Shaw Pond, Leicester.
Springfield,	62,059	1874	City,	Ludlow Reservoir, Ludlow; Jabish Brook, Belchertown; Axe Factory Brook, Belchertown; Broad Brook, Belchertown; Chapin Pond, Ludlow; Higher Brook, Ludlow; Five Mile Pond.
Ludlow,	3,536	1873	Private,	
Stockbridge,	2,081	1862	Private,	Lake Averic.
Stoneham,	-	-	- -	See Metropolitan Water District.
Stoughton,	5,442	1886	Town,	Muddy Brook.
Sunderland,	771	-	Private,	Springs.
Swampscott,	-	-	- -	See Metropolitan Water District.
Taunton,	31,036	1876	City,	Assawompsett Pond, Lakeville; Elder's Pond, Lakeville.
Tisbury,	1,149	1887	Private,*	Large well.
Uxbridge,	3,599	1879	Town,	Springs.
Wakefield,	9,290	1883	Town,	Crystal Lake.
Walpole,	3,572	1896	Town,	Tubular wells near Lowe Brook.
Waltham,	23,481	1873	City,	Large well near Charles River.
Ware,	8,263	1886	Town,	Large well and tubular wells near Muddy Brook.
Wareham,	3,432	1894	Private,	Jonathan's Pond.
Warren,	4,417	1837	Private,	Springs.
Watertown,	-	-	- -	See Metropolitan Water District.
Wayland,	2,303	1878	Town,	Storage reservoir on Snake Brook.
Webster,	8,804	1881	Town,	Large well and tubular wells near Lake Chaubungagungamaug.
Wellesley,	5,072	1884	Town,	Large well; filter-gallery; tubular wells near Rosemary Brook.
Westborough,	5,400	1879	Town,	Storage reservoir; filter basin.
West Brookfield,	1,448	1838	Private,	Springs.
Westfield,	12,310	1874	Town,	Moose Meadow Brook, Montgomery, on which is a storage reservoir; Tillotson Brook, Granville.
Weston,	1,834	1896	Private,	Large well; tubular wells.
West Springfield,	7,105	1875	Town,	Storage reservoir on Darby Brook; large well.
West Stockbridge,	1,158	-	Private,	Springs.
Weymouth,	11,324	1885	Town,	Great Pond.
Whitman,	-	-	- -	See Brockton.
Williamsburg,	1,926	1903	Town,	Unquomonk Brook.
Williamstown,	5,013	1859	Private,	Cold Spring; Sherman Spring; Paul Brook; Flora Glen Reservoir.
Winchendon,	5,001	1896	Town,	Large well.
Winchester,	7,248	1873	Town,	Three storage reservoirs.

* Works of water company taken by town early in 1905.

TABLE No. 1 — *Concluded.*

City or Town.	Population in 1900.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Winthrop, . . .	-	-	- -	See Metropolitan Water District.
Woburn, . . .	14,254	1873	City, . .	Filter-gallery near Horn Pond.
Worcester, . . .	118,421	1845	City, . .	Two reservoirs on Tatnuck Brook, Holden; storage reservoir on Lynde Brook, Leicester; four reservoirs on Kettle Brook, Leicester.

In presenting a comparison of the different waters, it is necessary to take into account differences in the physical characteristics of the various sources. The essential differences between surface waters (the waters of lakes, ponds and streams) and ground waters (those derived from wells, filter galleries, springs, etc.) have been described in previous reports, and need only be referred to here. The waters of the two classes differ so greatly in their chemical and biological characteristics that they cannot be judged by the same standards, and in comparing the quality of the waters of the different sources these two classes will be considered separately.

There are also important differences in the physical characteristics of surface-water sources, which affect very materially the quality of their waters. The waters of running streams under normal conditions contain but little organic life; but their waters take up the products of decaying organic matter from the grasses, leaves and soil with which they come in contact, and a greater or less quantity of mineral matter is also dissolved from the soil and rocks over which the waters flow. In ponds and storage reservoirs, on the other hand, vegetable and animal organisms find conditions more favorable to their growth and development, and the amount of such growths and their effect upon the quality of the water differs greatly in different sources. It is of interest to compare, also, the quality of the waters of natural ponds and lakes with that of the waters of artificial reservoirs, and sub-divisions have been made in the tables, so as to facilitate such comparisons.

SURFACE-WATER SUPPLIES.

The averages of all of the analyses of the various surface-water supplies made during the past five years have been calculated, and are presented in the following table.

In this table the analyses of the waters of the metropolitan sources are placed at the beginning, and the others follow in alphabetical order by towns.

In the case of most of the waters the results given in the table are the

average of from thirty to sixty analyses, made at regular intervals of one or two months. In a few cases the samples have been collected at longer intervals, but nearly always as often as once in three months, and in a very few cases samples have been collected as often as once in two weeks.

The use of some of the sources included in the table was begun less than five years ago, and the examinations have consequently covered a shorter period than five years. These cases are mentioned in the notes following the table.

Table No. 2. — *Averages of Chemical Analyses, from 1900 to 1904, Inclusive.*

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Metropolitan Water District.	Nashua River,*	.34	3.63	.0021	.0168	.0025	.23	.0066	.0001	.46	0.9
	Wachusett Reservoir,*	.20	2.86	.0034	.0154	.0031	.22	.0027	.0001	.34	0.9
	Sudbury Reservoir,	.24	3.68	.0032	.0156	.0024	.24	.0090	.0001	.39	1.2
	Framingham Reservoir No. 3.	.22	3.85	.0023	.0156	.0025	.26	.0120	.0001	.38	1.3
	Hopkinton Reservoir,	.51	3.70	.0033	.0210	.0029	.30	.0039	.0000	.67	0.8
	Ashland Reservoir,	.55	3.55	.0021	.0205	.0020	.24	.0026	.0000	.70	0.8
	Framingham Reservoir No. 2.	.69	4.19	.0032	.0226	.0024	.30	.0058	.0000	.80	1.0
	Lake Cochituate,	.22	4.85	.0030	.0208	.0033	.44	.0076	.0002	.44	2.0
	Chestnut Hill Reservoir,	.27	3.87	.0025	.0155	.0020	.26	.0105	.0001	.41	1.3
	Spot Pond,	.07	3.94	.0018	.0153	.0022	.29	.0033	.0000	.27	1.6
	Tap in State House,	.24	4.01	.0015	.0144	.0018	.30	.0119	.0001	.39	1.5
	Tap in Revere,	.11	3.95	.0014	.0143	.0019	.29	.0057	.0001	.30	1.7
	Tap in Quincy,	.23	4.07	.0010	.0184	.0015	.32	.0155	.0001	.38	1.6
Abington,	Big Sandy Pond,	.11	3.22	.0022	.0157	.0018	.62	.0020	.0000	.23	0.5
Adams,	Bassett Brook,	.02	3.72	.0005	.0039	.0006	.07	.0159	.0000	.13	2.5
	Dry Brook,	.17	7.22	.0013	.0090	.0010	.10	.0084	.0001	.32	4.9
Amherst,	Amethyst Brook Reservoir.*	.39	3.36	.0021	.0143	.0015	.13	.0037	.0000	.55	0.4
Andover,	Haggett's Pond,	.13	3.16	.0014	.0152	.0012	.30	.0020	.0000	.31	1.2
Athol,	Phillipston Reservoir,*	.62	3.43	.0049	.0334	.0110	.15	.0042	.0000	.76	0.6
	Buckman Brook Reservoir.*	.38	3.34	.0026	.0212	.0043	.14	.0029	.0000	.61	0.7
Barre,	Reservoir,*	.07	3.65	.0100	.0365	.0070	.11	.0010	.0000	.32	1.2
Brockton,	Salisbury Brook Reservoir.*	.55	3.70	.0019	.0233	.0036	.34	.0014	.0000	.69	0.6
	Silver Lake,	.09	2.95	.0010	.0136	.0018	.61	.0013	.0000	.26	0.4
Cambridge,	Lower Hobbs Brook Reservoir.	.13	4.89	.0029	.0265	.0045	.36	.0035	.0001	.41	2.1
	Stony Brook Reservoir,	.40	5.42	.0030	.0234	.0033	.44	.0138	.0002	.57	2.2
	Fresh Pond,	.18	6.88	.0053	.0227	.0055	.59	.0245	.0004	.36	3.2

* See Notes.

TABLE No. 2. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Cheshire, . .	Thunder Brook, . .	.01	4.42	.0009	.0039	.0004	.06	.0085	.0000	.07	3.3
Cheshire, . .	Kitchen Brook, . .	.01	5.01	.0013	.0052	.0022	.06	.0069	.0000	.06	3.6
Chester, . . .	Austin Brook, . .	.07	3.00	.0006	.0055	.0004	.08	.0070	.0001	.20	1.4
Chicopee, . .	Morton Brook, . .	.02	3.46	.0006	.0044	.0008	.12	.0052	.0000	.08	0.7
	Cooley Brook, . .	.59	4.12	.0019	.0139	.0024	.12	.0033	.0000	.61	0.9
Concord, . . .	Sandy Pond, . . .	.02	2.37	.0011	.0131	.0014	.26	.0018	.0000	.17	0.4
Dalton, . . .	Egypt Brook Reservoir,	.25	2.60	.0014	.0110	.0015	.06	.0162	.0000	.48	0.8
Danvers, . . .	Middleton Pond, . .	.54	3.81	.0017	.0193	.0025	.32	.0016	.0000	.73	1.2
Deerfield, . .	Roaring Brook,* . .	.03	5.82	.0009	.0039	.0006	.10	.0080	.0000	.08	3.5
Easthampton, . .	Bassett Brook, . .	.19	3.55	.0011	.0089	.0019	.11	.0048	.0001	.29	1.2
Fall River, . .	North Watuppa Lake, .	.15	3.35	.0013	.0180	.0025	.52	.0018	.0001	.37	0.6
Falmouth, . .	Long Pond, . . .	.00	2.90	.0014	.0099	.0009	.92	.0006	.0000	.08	0.2
Fitchburg, . .	Meetinghouse Pond, .	.06	2.36	.0016	.0136	.0019	.14	.0016	.0000	.25	0.5
	Scott Reservoir, . .	.16	2.47	.0057	.0192	.0056	.15	.0026	.0001	.32	0.3
Gardner, . . .	Crystal Lake, . .	.05	3.76	.0025	.0173	.0028	.30	.0073	.0000	.23	1.3
Gloucester, . .	Dike's Brook Reservoir,	.34	3.78	.0030	.0186	.0032	.85	.0030	.0000	.43	0.3
	Wallace Reservoir, .	.37	4.17	.0037	.0229	.0060	1.04	.0016	.0000	.49	0.4
	Haskell Brook Reservoir.*	.45	4.06	.0053	.0212	.0058	.87	.0010	.0000	.55	0.4
Great Barrington, .	East Mountain Reservoir.	.12	4.56	.0059	.0075	.0020	.10	.0008	.0002	.24	3.0
	Green River, . . .	.01	8.39	.0012	.0031	.0004	.09	.0270	.0000	.06	6.4
Greenfield, . .	Glen Brook Reservoir,	.02	5.10	.0007	.0038	.0002	.12	.0121	.0000	.07	3.3
Hatfield, . . .	Reservoir, . . .	.11	3.88	.0016	.0059	.0007	.12	.0119	.0000	.24	1.7
Haverhill, . .	Johnson's Pond, . .	.10	4.03	.0012	.0166	.0016	.35	.0022	.0000	.32	1.9
	Crystal Lake, . .	.16	3.02	.0013	.0166	.0019	.25	.0019	.0000	.36	0.9
	Kenoza Lake, . .	.09	3.71	.0013	.0149	.0016	.39	.0011	.0000	.25	1.7
	Pentucket Lake, . .	.04	3.61	.0010	.0160	.0019	.38	.0019	.0000	.22	1.6
	Millvale Reservoir, .	.52	4.77	.0017	.0207	.0022	.33	.0029	.0000	.70	1.7
Hingham, . .	Accord Pond, . .	.19	2.90	.0010	.0128	.0013	.58	.0016	.0000	.36	0.3
Hinsdale, . .	Storage reservoir, . .	.20	2.06	.0044	.0210	.0076	.06	.0041	.0000	.34	0.2
Holyoke, . . .	Whiting Street Reservoir.	.08	4.24	.0026	.0237	.0069	.13	.0024	.0001	.25	2.4
	Manhan River, . .	.32	3.67	.0014	.0133	.0022	.11	.0029	.0000	.46	1.4
	Wright and Ashley Pond.	.09	4.20	.0025	.0166	.0032	.13	.0033	.0001	.26	2.1
Hudson, . . .	Gates Pond, . . .	.08	2.53	.0028	.0151	.0019	.20	.0046	.0000	.21	0.6

* See Notes.

TABLE NO. 2. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid.			Nitrates.	Nitrites.		
					Total.	Sus-pended.					
Huntington,	Cold Brook,	.17	3.17	.0015	.0126	.0015	.10	.0040	.0000	.34	1.0
Ipswich,	Dow's Brook Reservoir,	.24	4.45	.0022	.0196	.0026	.56	.0044	.0001	.42	1.6
Lawrence,	Merrimack River, filtered.	.34	4.56	.0124	.0097	.0009	.28	.0255	.0001	.40	1.7
Lee,	Upper Reservoir on Codding Brook.	.35	2.79	.0070	.0278	.0069	.11	.0082	.0000	.63	0.4
	Codding Brook,	.18	3.56	.0014	.0095	.0008	.08	.0057	.0001	.36	1.7
Lenox,	Reservoir,	.05	8.05	.0015	.0122	.0020	.09	.0048	.0000	.18	5.8
Leominster,	Morse Reservoir,	.19	2.24	.0032	.0198	.0045	.14	.0024	.0001	.37	0.1
	Haynes Reservoir,	.17	2.26	.0047	.0319	.0108	.13	.0021	.0000	.38	0.1
	Fall Brook Reservoir,	.11	2.17	.0013	.0152	.0028	.14	.0021	.0000	.31	0.2
Longmeadow,	Cooley Brook,	.06	4.50	.0015	.0059	.0016	.17	.0265	.0002	.12	2.4
Lynn,	Birch Reservoir,	.34	3.96	.0051	.0245	.0043	.46	.0044	.0001	.50	1.1
	Breed's Reservoir,	.36	3.51	.0039	.0208	.0034	.47	.0028	.0000	.51	0.8
	Glen Lewis Reservoir,	.25	3.08	.0062	.0291	.0084	.37	.0019	.0000	.41	0.4
	Walden Reservoir,	.39	3.50	.0034	.0286	.0066	.39	.0021	.0000	.58	0.7
	Hawkes Reservoir,	.38	4.37	.0034	.0248	.0034	.48	.0031	.0001	.61	1.4
	Saugus River,	.86	7.49	.0050	.0331	.0037	.69	.0051	.0002	1.00	3.2
	Tap,	.36	4.10	.0030	.0215	.0027	.45	.0053	.0001	.55	1.2
Marlborough,	Lake Williams,	.08	4.12	.0022	.0225	.0041	.47	.0038	.0001	.26	1.6
	Millham Brook Reservoir.	.46	3.95	.0054	.0258	.0057	.30	.0071	.0001	.54	1.3
Maynard,	White Pond,	.04	2.67	.0008	.0119	.0019	.31	.0034	.0000	.15	0.6
Milford,	Charles River, filtered,*	.20	3.93	.0018	.0100	–	.28	.0165	.0001	.34	1.1
Montague,	Lake Pleasant,	.02	2.46	.0018	.0077	.0011	.12	.0040	.0000	.09	0.4
Nantucket,	Wannacomet Pond,	.07	6.78	.0037	.0287	.0091	2.29	.0018	.0000	.15	1.5
Natick,	Dug Pond,*	.13	4.95	.0077	.0187	.0024	.54	.0137	.0001	.27	2.1
New Bedford,	Old Storage Reservoir,	1.00	4.77	.0035	.0264	.0041	.53	.0021	.0000	1.01	0.9
	Little Quittacas Pond,	.25	3.34	.0015	.0169	.0022	.49	.0014	.0000	.45	0.6
	Great Quittacas Pond,	.43	3.42	.0017	.0180	.0026	.49	.0010	.0000	.62	0.6
	Tap at City Hall,	.22	3.32	.0016	.0174	.0019	.49	.0014	.0000	.43	0.7
North Adams,	Notch Brook Reservoir,	.03	6.75	.0047	.0101	.0022	.07	.0034	.0002	.14	5.0
	Broad Brook,	.16	3.63	.0019	.0085	.0012	.07	.0179	.0000	.34	1.8
Northampton,	Middle Reservoir,	.21	3.88	.0013	.0127	.0024	.11	.0033	.0000	.35	1.5
	West Brook,	.13	3.78	.0009	.0063	.0012	.09	.0037	.0000	.24	1.7
	Mountain Street Reservoir.*	.04	3.67	.0016	.0090	.0017	.09	.0051	.0000	.17	1.6

* See Notes.

TABLE NO. 2. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
North Andover,	Great Pond,	.12	3.39	.0022	.0190	.0026	.32	.0020	.0001	.32	1.2
Northborough,	Lower Reservoir,	.61	3.74	.0029	.0220	.0040	.22	.0051	.0000	.70	0.9
Northbridge,	Cook Allen Reservoir,*	.27	3.13	.0021	.0119	.0018	.19	.0019	.0000	.44	0.4
North Brookfield,	Doane Pond,	.53	3.21	.0065	.0246	.0047	.15	.0049	.0001	.50	0.5
	North Pond,	.52	3.35	.0056	.0271	.0053	.14	.005[illegible]	.0000	.59	0.5
Northfield,	Reservoir,	.16	2.94	.0006	.0077	.0009	.10	.0021	.0000	.28	0.7
Norwood,	Buckmaster Pond,	.10	3.04	.0073	.0176	.0030	.34	.0033	.0001	.23	0.7
Palmer,	Lower Reservoir,	.27	3.36	.0010	.0148	.0026	.13	.0025	.0000	.35	0.6
Peabody,	Brown's Pond,	.15	3.10	.0015	.0169	.0027	.52	.0033	.0001	.31	0.6
	Spring Pond,	.03	4.00	.0062	.0138	.0025	.63	.0012	.0000	.16	1.5
Pittsfield,	Ashley Lake,*	.31	4.57	.0080	.0219	.0046	.16	.0041	.0001	.43	2.3
	Ashley Brook,*	.14	6.13	.0052	.0157	.0022	.10	.0080	.0000	.27	4.6
	Hathaway Brook,	.05	8.28	.0020	.0074	.0008	.11	.0140	.0000	.14	6.7
	Mill Brook,	.03	5.03	.0011	.0059	.0013	.08	.0071	.0000	.12	3.6
	Sacket Brook,	.07	6.43	.0024	.0093	.0013	.09	.0141	.0000	.16	5.1
Plymouth,	Little South Pond,	.01	2.48	.0012	.0139	.0019	.68	.0016	.0000	.11	0.1
Randolph,	Great Pond,	.40	3.96	.0012	.0174	.0013	.53	.0042	.0000	.56	1.0
Rockport,	Cape Pond,	.27	9.12	.0114	.0301	.0090	3.52	.0077	.0001	.41	1.3
Rutland,	Muschopauge Lake,	.05	2.17	.0023	.0136	.0018	.18	.0020	.0000	.16	0.4
Salem,	Wenham Lake,	.12	5.47	.0047	.0187	.0039	.75	.0062	.0002	.30	2.2
	Longham Reservoir,	.94	6.26	.0085	.0309	.0047	.91	.0143	.0002	.91	1.8
Southbridge,	Hatchet Brook Reservoir.	.35	3.15	.0025	.0174	.0035	.15	.0033	.0000	.50	0.6
South Hadley,	Leaping Well Reservoir,	.03	2.59	.0027	.0138	.0045	.14	.0045	.0000	.13	0.5
	Buttery Brook Reservoir.	.17	3.78	.0039	.0136	.0043	.24	.0262	.0003	.24	0.9
Spencer,	Shaw Pond,	.08	2.31	.0013	.0125	.0009	.16	.0051	.0000	.12	0.7
Springfield,	Ludlow Canal,	.37	3.46	.0023	.0158	.0025	.14	.0048	.0000	.46	1.0
	Ludlow Reservoir,	.27	2.88	.0042	.0301	.0120	.13	.0055	.0001	.36	0.7
	Chapin Pond,	.04	2.25	.0010	.0193	.0030	.10	.0018	.0000	.22	0.4
	Five Mile Pond,	.07	2.50	.0058	.0210	.0025	.14	.0018	.0000	.25	0.4
Stockbridge,	Lake Averic,	.09	5.70	.0023	.0158	.0023	.07	.0028	.0000	.26	3.7
Taunton,	Assawompsett Pond,	.26	3.16	.0021	.0183	.0026	.48	.0016	.0000	.50	0.5
	Elder's Pond,	.05	2.75	.0011	.0160	.0022	.47	.0017	.0000	.27	0.4
Wakefield,	Crystal Lake,	.16	4.49	.0044	.0195	.0032	.57	.0073	.0001	.31	1.9

* See Notes.

TABLE NO. 2. — *Averages of Chemical Analyses, etc.* — Concluded.

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Wareham,	Jonathan's Pond,	.02	2.33	.0011	.0098	.0011	.70	.0015	.0000	.11	0.1
Wayland,	Snake Brook Reservoir.	.80	4.53	.0045	.0821	.0037	.28	.0062	.0000	.95	1.3
Westfield,	Montgomery Reservoir,	.48	2.65	.0032	.0192	.0036	.11	.0032	.0000	.59	0.3
	Tillotson Brook,	.08	2.61	.0011	.0070	.0010	.11	.0037	.0000	.18	0.5
West Springfield,	Darby Brook Reservoir,	.14	5.13	.0059	.0180	.0072	.18	.0057	.0001	.27	2.6
Weymouth,	Great Pond,	.69	3.89	.0023	.0189	.0020	.49	.0030	.0000	.77	0.5
Whitman,	Hobart's Pond,*	.60	6.22	.0057	.0318	.0041	.96	.0070	.0002	.81	1.8
Williamstown,	Flora Glen Reservoir,	.07	5.43	.0025	.0168	.0048	.07	.0034	.0000	.13	3.5
	Paul Brook,	.02	4.15	.0003	.0035	.0005	.06	.0149	.0000	.06	2.8
Winchester,	North Reservoir,	.08	4.51	.0040	.0232	.0048	.45	.0028	.0001	.27	2.0
	South Reservoir,	.09	3.15	.0054	.0214	.0028	.30	.0037	.0001	.27	1.2
	Middle Reservoir,	.20	3.42	.0081	.0323	.0072	.31	.0049	.0002	.39	1.1
Worcester,	Kent Reservoir,	.29	3.24	.0031	.0188	.0033	.17	.0070	.0000	.46	0.9
	Leicester Reservoir,	.23	3.01	.0041	.0153	.0021	.17	.0064	.0000	.40	0.8
	Upper Holden Reservoir.	.14	2.16	.0025	.0153	.0042	.13	.0024	.0000	.30	0.3
	Lower Holden Reservoir.	.07	2.26	.0022	.0116	.0021	.15	.0027	.0000	.19	0.6

* See Notes.

NOTES.

Metropolitan Water District, Nashua River. — The water of this source may have been unfavorably affected by the operations incident to the construction of the Wachusett Reservoir during the period covered by the analyses.

Metropolitan Water District, Wachusett Reservoir. — This is a new reservoir, not yet completed. A considerable quantity of water had been collected in April, 1904, and examinations of the source were begun at that time.

Amherst, Amethyst Brook Reservoir. — This reservoir was drawn off in 1904, and the soil and organic matter removed from its bottom, or covered with sand.

Athol, Phillipston Reservoir. — The water of this reservoir is filtered through a mechanical filter before being supplied to the town.

Athol, Buckman Brook Reservoir. — Previous to 1903 the reservoir had a very small capacity; a new reservoir of very much larger capacity was completed in the latter part of 1903. The analyses represent the results of examinations of both reservoirs.

Barre, Reservoir. — Much of the water entering is ground water, which deteriorates rapidly on exposure to light in the reservoir.

Brockton. — Since the introduction of water from Silver Lake in 1904 the use of the Brockton storage reservoir has been discontinued.

Deerfield, Roaring Brook. — This source was first used in 1903.

Gloucester, Haskell Brook Reservoir. — This reservoir was completed and first used in 1903.

Milford, Charles River, filtered. — The water of Charles River is filtered through an artificial sand filter, and is mingled with ground water obtained from wells near the river.

Natick, Dug Pond. — Dug Pond was abandoned as a source of water supply by Natick in 1903.

Northampton, Mountain Street Reservoir. — This reservoir, which receives water from West Brook, was completed in 1902. It was emptied again in 1903, and has not since been filled.

Northbridge, Cook Allen Reservoir. — This reservoir was completed in 1902.

Pittsfield. — The water of Ashley Lake flows down Ashley Brook, and is supplied thence to the city.

Whitman, Hobart's Pond. — This pond was abandoned as a source of water supply for Whitman at the end of the year 1904, and water was introduced from the works of the city of Brockton, water being supplied from Silver Lake.

First in importance in comparing the waters of the various sources are the conditions affecting their safety for drinking, and these depend chiefly upon their comparative freedom from danger of contamination by the wastes of human life and industry.

Nearly all of the water-sheds of streams, ponds and reservoirs in Massachusetts used as sources of water supply contain human habitations; but the use of unpurified water from sources polluted by the direct discharge of the sewage from the sewers of towns and villages has been discontinued. The degree of danger to which the health of a community is exposed by reason of the presence of population within the water-shed of the source from which it derives its supply of drinking water depends upon many circumstances. When sewage is discharged upon the ground within a water-shed, it may, if the soil is fine and impervious, or has been rendered impervious by frost, find its way directly over the surface and into a neighboring stream and thence into the distributing system of a public water supply, within a very few days or even a few hours of the time of its discharge. On the other hand, the circumstances may be such (as, for example, when a polluted stream flows into a large lake or reservoir) that the polluting matter may be many weeks or months in passing from the point where it enters the stream to the intake pipes of the water-supply system, and its noxious qualities may be wholly removed by sedimentation, oxidation or other processes which take place in ponds and reservoirs. If sewage or other polluting matter is discharged upon land having a porous soil it may sink into the ground and become purified by filtration before entering the stream to such an extent that the resulting pollution will not cause injury to health. In some cases, where the water-shed of a source of supply contains a large population, sewers have been constructed in which the sewage and foul drainage are removed and disposed of outside of the water-shed. Many of the sources of supply in the State are now protected by the enforcement of rules and regulations which have been established from time to time by the State Board of Health, under the provisions of public statutes, but there are still cases in which adequate sanitary protection is not provided. In some cases cities and towns have purchased and removed all of the buildings within the water-sheds of their sources of water supply, thus preventing further danger of pollution from these places.

While the number of persons living within a water-shed is in a general way an index of the extent to which a source is exposed to danger of sewage pollution, the actual danger to which users of the water are exposed depends, as has been indicated, upon many circumstances, and a thorough knowledge of the conditions affecting each source is necessary to determine definitely the relative sanitary quality of the various waters.

The sources in the water-sheds of which rules and regulations have been established for the protection of the purity of the water are the following: —

TABLE No. 3.

Metropolitan Water District, Ashland Reservoir, Chestnut Hill Reservoir, Framingham Reservoir No. 2, Framingham Reservoir No. 3, Hopkinton Reservoir, Lake Cochituate, Nashua River, Sudbury Reservoir, Wachusett Reservoir.
Abington and Rockland, Big Sandy Pond.
Attleborough, Orr's Pond.*
Cambridge, Stony Brook Reservoir.
Danvers, Middleton Pond, Swan's Pond.
Easthampton, Bassett Brook.
Fall River, North Watuppa Lake.
Fitchburg, Falulah Reservoir, Scott Reservoir, Smith Reservoir, Meetinghouse Pond.
Greenfield, Glen Brook Reservoir.
Haverhill, Kenoza Lake, Millvale Reservoir.
Lincoln, Sandy Pond.
Marlborough, Lake Williams, Millham Brook Reservoir.
Northampton, Roberts' Meadow Brook, West Brook, Mountain Street Reservoir.
Norwood, Buckmaster Pond.
Peabody, Reservoir, Brown's Pond, Spring Pond.
Pittsfield, Ashley Lake, Ashley Brook, Sacket Brook, Hathaway Brook, Mill Brook.
Plymouth, Lout Pond, Little South Pond, Great South Pond.
Randolph and Holbrook, Great Pond.
Rockport, Cape Pond.
Salem, Wenham Lake, Longham Reservoir.
Springfield, Jabish Brook, Broad Brook, Axe Factory Brook, Ludlow Reservoir, Chapin Pond, Five Mile Pond, Higher Brook, lower basin of Van Horn Reservoir.
Taunton, Elder's Pond, Assawompsett Pond.
Wakefield, Crystal Lake.
Weymouth, Great Pond.
Worcester, Tatnuck Brook, Lynde Brook, Kettle Brook.

Sewers have been built which remove all or a part of the sewage from the water-sheds of the following sources: —

Metropolitan Water District, Framingham Reservoir No. 2, Sudbury Reservoir, Framingham Reservoir No. 3, Lake Cochituate.
Fall River, North Watuppa Lake.
Gardner, Crystal Lake.
Haverhill, Pentucket Lake.
Lynn, Saugus River.
Marlborough, Lake Williams.
Natick, Dug Pond.
Wakefield, Crystal Lake.

The approximate population living within the water-sheds of the various sources of supply has been computed from the best information available, and the results are presented in the following table: —

TABLE No. 4. — *Surface-water Sources, arranged in Groups according to the Population on their Water-sheds.*

GROUP I. — *Sources having a Population upon their Water-sheds of Less than 10 per Square Mile.*

City or Town.	Source.	City or Town.	Source.
Adams,	Bassett Brook.	Gloucester,	Dike's Brook Reservoir.
Athol,	Buckman Brook Reservoir.	Gloucester,	Haskell Brook Reservoir.
Brookfield,	Reservoir.	Gloucester,	Wallace Reservoir.
Cheshire,	Kitchen Brook.	Great Barrington,	East Mountain Reservoir.
Chicopee,	Morton Brook.	Hatfield,	Reservoir.
Dalton,	Egypt Brook Reservoir.	Hinsdale,	Storage Reservoir.

* Not used directly as a source of water supply.

TABLE NO. 4. — *Surface-water Sources, arranged in Groups, etc.* — Continued.

GROUP I. — *Sources having a Population upon their Water-sheds of Less than 10 per Square Mile* — Concluded.

City or Town.	Source.	City or Town.	Source.
Holyoke,	Whiting Street Reservoir.	Southbridge,	Hatchet Brook Reservoir.
Holyoke,	Wright and Ashley Pond.	South Hadley,	Leaping Well Reservoir.
Lee,	Codding Brook.	Spencer,	Shaw Pond.
Leominster,	Morse Reservoir.	Stockbridge,	Lake Averic.
Lynn,	Glen Lewis Reservoir.	Wareham,	Jonathan's Pond.
Lynn,	Walden Reservoir.	West Springfield,	Darby Brook Reservoir.
Nantucket,	Wannacomet Pond.	Williamstown,	Flora Glen Reservoir.
North Adams,	Broad Brook.	Williamstown,	Paul Brook.
North Adams,	Notch Brook Reservoir.	Winchester,	North Reservoir.
Northbridge,	Cook Allen Reservoir.	Winchester,	Middle Reservoir.
Northfield,	Reservoir.	Winchester,	South Reservoir.
Pittsfield,	Ashley Lake.		

GROUP II. — *Sources having a Population upon their Water-sheds of from 10 to 50 per Square Mile.*

City or Town.	Source.	City or Town.	Source.
Metropolitan Water District.	Ashland Reservoir.	Maynard,	White Pond.
Adams,	Dry Brook.	New Bedford,	Old Storage Reservoir.
Amherst,	Amethyst Brook Reservoir.	Northampton,	Middle Reservoir.
Andover,	Haggett's Pond.	Northampton,	Mountain Street Reservoir.
Brockton,	Silver Lake.	Northampton,	West Brook.
Cambridge,	Lower Hobbs Brook Reservoir.	Northborough,	Lower Reservoir.
Cheshire,	Thunder Brook.	North Brookfield,	Doane Pond.
Chester,	Austin Brook.	North Brookfield,	North Pond.
Concord,	Sandy Pond.	Palmer,	Lower Reservoir.
Danvers,	Middleton Pond.	Pittsfield,	Ashley Brook.
Deerfield,	Roaring Brook.	Pittsfield,	Hathaway Brook.
Easthampton,	Bassett Brook.	Pittsfield,	Mill Brook.
Falmouth,	Long Pond.	Pittsfield,	Sacket Brook.
Fitchburg,	Falulah Reservoir.	Rutland,	Muschopauge Lake.
Fitchburg,	Scott Reservoir.	Springfield,	Chapin Pond.
Great Barrington,	Green River.	Springfield,	Five Mile Pond.
Greenfield,	Glen Brook Reservoir.	Springfield,	Ludlow Reservoir.
Haverhill,	Crystal Lake.	Wayland,	Snake Brook Reservoir.
Holyoke,	Manhan River.	Westfield,	Montgomery Reservoir.
Huntington,	Cold Brook.	Westfield,	Tillotson Brook.
Lenox,	Reservoir.	Worcester,	Kent Reservoir.
Leominster,	Fall Brook Reservoir.	Worcester,	Leicester Reservoir.
Leominster,	Haynes Reservoir.	Worcester,	Lower Holden Reservoir.
Lynn,	Breed's Reservoir.	Worcester,	Upper Holden Reservoir.

TABLE NO. 4.— *Surface-water Sources, arranged in Groups, etc.*— Concluded.

GROUP III.— *Sources having a Population upon their Water-sheds of from 50 to 100 per Square Mile.*

City or Town.	Source.	City or Town.	Source.
Athol,	Phillipston Reservoir.	New Bedford,	Little Quittacas Pond.
Brockton,	Salisbury Brook Reservoir.	North Andover,	Great Pond.
Cambridge,	Stony Brook Reservoir.	Peabody,	Brown's Pond.
Chicopee,	Cooley Brook.	Plymouth,	Little South Pond.
Fitchburg,	Meetinghouse Pond.	Rockport,	Cape Pond.
Haverhill,	Johnson's Pond.	South Hadley,	Buttery Brook Reservoir.
Haverhill,	Millvale Reservoir.	Taunton,	Assawompsett Pond.
Hingham,	Fulling Mill Pond.	Taunton,	Elder's Pond.
Longmeadow,	Cooley Brook.	Westborough,	Sandra Pond.
Lynn,	Hawkes Reservoir.	Weymouth,	Great Pond.
New Bedford,	Great Quittacas Pond.		

GROUP IV.— *Sources having a Population upon their Water-sheds of from 100 to 200 per Square Mile.*

Metropolitan Water District.	Nashua River.	Lawrence,	Merrimack River, filtered.
Metropolitan Water District.	Wachusett Reservoir.	Lynn,	Saugus River.*
Abington,	Big Sandy Pond.	Marlborough,	Millham Brook Reservoir.
Barre,	Reservoir.	Milford,	Charles River, filtered.
Fall River,	North Watuppa Lake.*	Montague,	Lake Pleasant.
Haverhill,	Kenoza Lake.	Norwood,	Buckmaster Pond.
Hingham,	Accord Pond.	Randolph,	Great Pond.
Hudson,	Gates Pond.	Salem,	Longham Reservoir.
Ipswich,	Dow's Brook Reservoir.	Salem,	Wenham Lake.

GROUP V.— *Sources having a Population upon their Water-sheds of more than 200 per Square Mile.*

Metropolitan Water District.	Hopkinton Reservoir.	Haverhill,	Pentucket Lake.*
Metropolitan Water District.	Framingham Reservoir No. 2.†	Lynn,	Birch Reservoir.
Metropolitan Water District.	Sudbury Reservoir.†	Marlborough,	Lake Williams.†
Metropolitan Water District.	Framingham Reservoir No. 3.†	Natick,	Dug Pond.‡
Metropolitan Water District.	Lake Cochituate.†	Peabody,	Spring Pond.
Cambridge,	Fresh Pond.†	Wakefield,	Crystal Lake.*
Gardner,	Crystal Lake.*	Whitman,	Hobart's Pond.‡

* Sewers remove a portion of the sewage from within the water-shed.
† Sewers have been built to remove sewage from water-shed. ‡ Abandoned.

Next in importance to the freedom of the water from danger of pollution by sewage is its relative freedom from organic matter; and the best index of the quantity of organic matter present in surface waters is furnished by the determination of the ammonia, especially the albuminoid ammonia. The total quantity of albuminoid ammonia in the various sources of water supply and the quantity of albuminoid ammonia in suspension are shown in the following table, in which the waters have been arranged in accordance with the average total quantity of albuminoid ammonia for the past five years. The averages of the maximum amounts in each year of the five are also presented. For convenience, the quantity of free ammonia is also included in the table.

TABLE NO. 5. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, arranged in Order of Albuminoid Ammonia.*

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Great Barrington,	Green River,	.0031	.0044	.0060	.0004	.0012
Williamstown,	Paul Brook,	.0035	.0045	.0064	.0005	.0008
Greenfield,	Glen Brook Reservoir,	.0038	.0060	.0072	.0002	.0007
Adams,	Bassett Brook,	.0039	.0054	.0062	.0006	.0005
Cheshire,	Thunder Brook,	.0039	.0043	.0066	.0004	.0009
Deerfield,	Roaring Brook,	.0039	.0055	.0060	.0006	.0009
Chicopee,	Morton Brook,	.0044	.0059	.0098	.0008	.0006
Cheshire,	Kitchen Brook,	.0052	.0090	.0196	.0022	.0018
Chester,	Austin Brook,	.0055	.0055	.0068	.0004	.0006
Hatfield,	Reservoir,	.0059	.0132	.0276	.0007	.0016
Longmeadow,	Cooley Brook,	.0059	.0079	.0118	.0016	.0015
Pittsfield,	Mill Brook,	.0059	.0107	.0224	.0013	.0011
Northampton,	West Brook,	.0063	.0158	.0158	.0012	.0009
Westfield,	Tillotson Brook,	.0070	.0090	.0108	.0010	.0011
Pittsfield,	Hathaway Brook,	.0074	.0109	.0160	.0008	.0020
Great Barrington,	East Mountain Reservoir,	.0075	.0096	.0108	.0020	.0059
Montague,	Lake Pleasant,	.0077	.0098	.0118	.0011	.0018
Northfield,	Reservoir,	.0077	.0113	.0164	.0009	.0008
North Adams,	Broad Brook,	.0085	.0146	.0204	.0012	.0019
Easthampton,	Bassett Brook,	.0089	.0158	.0278	.0019	.0011

TABLE NO. 5. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, arranged in Order of Albuminoid Ammonia* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Adams,	Dry Brook,	.0090	.0129	.0194	.0010	.0013
Northampton,	Mountain Street Reservoir,	.0090	.0120	.0122	.0017	.0016
Pittsfield,	Sacket Brook,	.0093	.0144	.0310	.0013	.0024
Lee,	Codding Brook,	.0095	.0126	.0166	.0008	.0014
Lawrence,	Merrimack River, filtered,	.0097	.0138	.0172	.0009	.0124
Wareham,	Jonathan's Pond,	.0098	.0124	.0200	.0011	.0011
Falmouth,	Long Pond,	.0099	.0127	.0184	.0009	.0014
Milford,	Charles River, filtered,	.0100	.0161	.0168	-	.0018
North Adams,	Notch Brook Reservoir,	.0101	.0161	.0240	.0022	.0047
Dalton,	Egypt Brook Reservoir,	.0110	.0128	.0158	.0015	.0014
Worcester,	Lower Holden Reservoir,	.0116	.0149	.0162	.0021	.0022
Maynard,	White Pond,	.0119	.0162	.0248	.0019	.0008
Northbridge,	Cook Allen Reservoir,	.0119	.0155	.0192	.0018	.0021
Lenox,	Reservoir,	.0122	.0178	.0220	.0020	.0015
Spencer,	Shaw Pond,	.0125	.0154	.0188	.0009	.0013
Huntington,	Cold Brook,	.0126	.0177	.0190	.0015	.0015
Northampton,	Middle Reservoir,	.0127	.0216	.0260	.0024	.0013
Hingham,	Accord Pond,	.0128	.0152	.0180	.0013	.0010
Concord,	Sandy Pond,	.0131	.0156	.0210	.0014	.0011
Holyoke,	Manhan River,	.0133	.0196	.0276	.0022	.0014
Metropolitan Water District,	Tap in Quincy,	.0134	.0160	.0184	.0015	.0010
Brockton,	Silver Lake,	.0136	.0208	.0286	.0018	.0010
Fitchburg,	Meetinghouse Pond,	.0136	.0171	.0198	.0019	.0016
Rutland,	Muschopauge Lake,	.0136	.0174	.0250	.0018	.0023
South Hadley,	Buttery Brook Reservoir,	.0136	.0180	.0200	.0043	.0039
Peabody,	Spring Pond,	.0138	.0150	.0166	.0025	.0062
South Hadley,	Leaping Well Reservoir,	.0138	.0196	.0262	.0045	.0027
Chicopee,	Cooley Brook,	.0139	.0228	.0336	.0024	.0019
Plymouth,	Little South Pond,	.0139	.0169	.0204	.0019	.0012
Metropolitan Water District,	Tap in Revere,	.0143	.0170	.0186	.0019	.0014
Amherst,	Amethyst Brook Reservoir,	.0143	.0201	.0364	.0015	.0021

TABLE No. 5. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, arranged in Order of Albuminoid Ammonia* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Metropolitan Water District,	Tap in State House,	.0144	.0175	.0190	.0018	.0015
Palmer,	Lower Reservoir,	.0148	.0209	.0850	.0026	.0010
Haverhill,	Kenoza Lake,	.0149	.0167	.0176	.0016	.0013
Hudson,	Gates Pond,	.0151	.0184	.0230	.0019	.0023
Andover,	Haggett's Pond,	.0152	.0171	.0192	.0012	.0914
Leominster,	Fall Brook Reservoir,	.0152	.0184	.0198	.0023	.0013
Metropolitan Water District,	Spot Pond,	.0153	.0196	.0234	.0022	.0018
Worcester,	Leicester Reservoir,	.0153	.0181	.0200	.0021	.0041
Worcester,	Upper Holden Reservoir,	.0153	.0227	.0268	.0042	.0025
Metropolitan Water District,	Wachusett Reservoir,	.0154	.0192	.0192	.0031	.0034
Metropolitan Water District,	Chestnut Hill Reservoir,	.0155	.0188	.0210	.0020	.0025
Metropolitan Water District,	Sudbury Reservoir,	.0156	.0207	.0242	.0024	.0032
Metropolitan Water District,	Framingham Reservoir No. 3,	.0156	.0206	.0284	.0025	.0023
Abington,	Big Sandy Pond,	.0157	.0188	.0236	.0018	.0022
Pittsfield,	Ashley Brook,	.0157	.0216	.0256	.0022	.0052
Springfield,	Ludlow Canal,	.0158	.0276	.0440	.0025	.0023
Stockbridge,	Lake Averic,	.0158	.0200	.0226	.0023	.0023
Haverhill,	Pentucket Lake,	.0160	.0186	.0244	.0019	.0010
Taunton,	Elder's Pond,	.0160	.0190	.0206	.0022	.0011
Haverhill,	Johnson's Pond,	.0166	.0200	.0266	.0016	.0012
Haverhill,	Crystal Lake,	.0166	.0192	.0216	.0019	.0013
Holyoke,	Wright and Ashley Pond,	.0166	.0215	.0238	.0032	.0025
Metropolitan Water District,	Nashua River,	.0168	.0222	.0306	.0025	.0021
Williamstown,	Flora Glen Reservoir,	.0168	.0249	.0446	.0048	.0025
New Bedford,	Little Quittacas Pond,	.9169	.0196	.0244	.0022	.0015
Peabody,	Brown's Pond,	.0169	.0201	.0222	.0027	.0015
Gardner,	Crystal Lake,	.0173	.0210	.0248	.0028	.0025
New Bedford,	Tap at City Hall,	.0174	.0207	.0228	.0019	.0016
Randolph,	Great Pond,	.0174	.0206	.0236	.0013	.0012
Southbridge,	Hatchet Brook Reservoir,	.0174	.0261	.0316	.0035	.0025
Norwood,	Buckmaster Pond,	.0176	.0234	.0322	.0030	.0073

TABLE NO. 5.—*Albuminoid Ammonia and Free Ammonia in Surface Waters, arranged in Order of Albuminoid Ammonia*—Continued.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Average of the Maxima for Five Years.	Maximum during Five Years.	Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Fall River,	North Watuppa Lake,	.0180	.0216	.0252	.0025	.0013
New Bedford,	Great Quittacas Pond,	.0180	.0208	.0268	.0026	.0017
West Springfield,	Darby Brook Reservoir,	.0180	.0255	.0300	.0072	.0059
Taunton,	Assawompsett Pond,	.0183	.0233	.0340	.0026	.0021
Gloucester,	Dike's Brook Reservoir,	.0186	.0241	.0300	.0032	.0030
Natick,	Dug Pond,	.0187	.0213	.0242	.0024	.0077
Salem,	Wenham Lake,	.0187	.0258	.0292	.0039	.0047
Worcester,	Kent Reservoir,	.0188	.0276	.0324	.0033	.0061
Weymouth,	Great Pond,	.0189	.0214	.0248	.0020	.0028
North Andover,	Great Pond,	.0190	.0228	.0272	.0026	.0022
Fitchburg,	Scott Reservoir,	.0192	.0265	.0332	.0056	.0057
Westfield,	Montgomery Reservoir,	.0192	.0246	.0356	.0036	.0032
Danvers,	Middleton Pond,	.0193	.0222	.0250	.0025	.0017
Springfield,	Chapin Pond,	.0193	.0216	.0254	.0030	.0010
Wakefield,	Crystal Lake,	.0195	.0231	.0280	.0032	.0044
Ipswich,	Dow's Brook Reservoir,	.0196	.0269	.0308	.0026	.0022
Leominster,	Morse Reservoir,	.0198	.0249	.0316	.0045	.0032
Metropolitan Water District,	Ashland Reservoir,	.0205	.0242	.0294	.0020	.0021
Haverhill,	Millvale Reservoir,	.0207	.0248	.0296	.0022	.0017
Metropolitan Water District,	Lake Cochituate,	.0208	.0271	.0308	.0033	.0030
Lynn,	Breed's Reservoir,	.0208	.0269	.0368	.0034	.0039
Metropolitan Water District,	Hopkinton Reservoir,	.0210	.0267	.0302	.0029	.0033
Hinsdale,	Storage Reservoir,	.0210	.0299	.0300	.0076	.0044
Springfield,	Five Mile Pond,	.0210	.0262	.0364	.0025	.0058
Athol,	Buckman Brook Reservoir,	.0212	.0328	.0432	.0048	.0026
Gloucester,	Haskell Brook Reservoir,	.0212	.0353	.0398	.0058	.0053
Winchester,	South Reservoir,	.0214	.0260	.0302	.0028	.0054
Lynn,	Tap,	.0215	.0315	.0364	.0027	.0030
Pittsfield,	Ashley Lake,	.0219	.0310	.0312	.0046	.0060
Northborough,	Lower Reservoir,	.0220	.0295	.0352	.0040	.0029
Marlborough,	Lake Williams,	.0225	.0260	.0292	.0041	.0022

TABLE NO. 5.—*Albuminoid Ammonia and Free Ammonia in Surface Waters, arranged in Order of Albuminoid Ammonia*—Concluded.

[Parts per 100,000.]

CITY OR TOWN.	SOURCE.	ALBUMINOID AMMONIA. TOTAL. Average for Five Years.	ALBUMINOID AMMONIA. TOTAL. Average of the Maxima for Five Years.	ALBUMINOID AMMONIA. TOTAL. Maximum during Five Years.	ALBUMINOID AMMONIA. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Metropolitan Water District,	Framingham Reservoir No. 2,	.0226	.0297	.0372	.0024	.0032
Cambridge,	Fresh Pond,	.0227	.0358	.0578	.0055	.0053
Gloucester,	Wallace Reservoir,	.0229	.0301	.0384	.0060	.0037
Winchester,	North Reservoir,	.0232	.0298	.0432	.0048	.0040
Brockton,	Salisbury Brook Reservoir,	.0233	.0308	.0336	.0036	.0019
Cambridge,	Stony Brook Reservoir,	.0234	.0290	.0306	.0033	.0030
Holyoke,	Whiting Street Reservoir,	.0237	.0362	.0514	.0069	.0026
Nantucket,	Wannacomet Pond,	.0237	.0578	.1540	.0091	.0037
Lynn,	Birch Reservoir,	.0245	.0345	.0432	.0043	.0051
North Brookfield,	Doane Pond,	.0246	.0331	.0428	.0047	.0065
Lynn,	Hawkes Reservoir,	.0248	.0344	.0424	.0034	.0034
Marlborough,	Millham Brook Reservoir,	.0258	.0335	.0436	.0057	.0054
New Bedford,	Old Storage Reservoir,	.0264	.0376	.0580	.0041	.0035
Cambridge,	Lower Hobbs Brook Reservoir,	.0265	.0319	.0358	.0045	.0029
North Brookfield,	North Pond,	.0271	.0357	.0444	.0058	.0056
Lee,	Upper Reservoir on Codding Brook.	.0278	.0397	.0494	.0069	.0070
Lynn,	Walden Reservoir,	.0286	.0366	.0444	.0066	.0034
Lynn,	Glen Lewis Reservoir,	.0291	.0483	.0860	.0064	.0062
Rockport,	Cape Pond,	.0301	.0430	.0584	.0090	.0114
Springfield,	Ludlow Reservoir,	.0301	.1121	.2670	.0120	.0042
Salem,	Longham Reservoir,	.0309	.0479	.0575	.0047	.0065
Whitman,	Hobart's Pond,	.0318	.0399	.0420	.0041	.0057
Leominster,	Haynes Reservoir,	.0319	.0429	.0575	.0108	.0047
Wayland,	Snake Brook Reservoir,	.0321	.0338	.0558	.0037	.0045
Winchester,	Middle Reservoir,	.0323	.0456	.0693	.0072	.0081
Lynn,	Saugus River,	.0331	.0499	.0584	.0037	.0050
Athol,	Phillipston Reservoir,	.0334	.0575	.1800	.0110	.0049
Barre,	Reservoir,	.0365	.0365	.0366	.0070	.0100

In the foregoing table, of the first 27 waters in which the average albuminoid ammonia has been less than .0100 parts per 100,000, 19 are streams,

3 are natural ponds — viz., Lake Pleasant in Montague, Jonathan's Pond in Wareham and Long Pond in Falmouth — and 5 are artificial storage reservoirs — Greenfield, Hatfield, Great Barrington, Northfield and the Mountain Street Reservoir in Northampton. Three of these reservoirs — those at Hatfield, Northfield and Great Barrington — are very small, while the Mountain Street Reservoir of the city of Northampton is new, and the analyses cover a period of less than a year. On the other hand, among the 28 waters at the foot of the list having an average of more than .0225 of a part per 100,000 of albuminoid ammonia, there are no streams and only two natural ponds, — Cape Pond, in Rockport, and Fresh Pond, in Cambridge, — the latter being supplied chiefly, however, with water from the Stony Brook storage reservoir. With these exceptions all are storage reservoirs, all but one of which — Hawkes Reservoir at Lynn — were formed by the flooding of areas from which the soil, stumps and other organic matter were not removed. Hawkes Reservoir receives part of its water from the highly polluted Saugus River. The reservoir which stands at the foot of this list — that at Barre — is a comparatively small one; and the poor quality of the water is largely due to the fact that much of the water which enters the reservoir is spring water, which deteriorates rapidly on exposure to light. For convenience in comparison, this table has been sub-divided into three classes, viz.: (1) streams; (2) natural ponds; (3) artificial reservoirs.

TABLE NO. 6. — *Albuminoid Ammonia and Free Ammonia in the Water of Streams, arranged in Order of Albuminoid Ammonia.*

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Great Barrington,	Green River,	.0031	.0044	.0060	.0004	.0012
Williamstown,	Paul Brook,	.0035	.0045	.0064	.0005	.0008
Adams,	Bassett Brook,	.0039	.0054	.0062	.0006	.0005
Cheshire,	Thunder Brook,	.0039	.0048	.0066	.0004	.0009
Deerfield,	Roaring Brook,	.0039	.0055	.0060	.0006	.0009
Chicopee,	Morton Brook,	.0044	.0059	.0098	.0008	.0006
Cheshire,	Kitchen Brook,	.0052	.0090	.0196	.0022	.0013
Chester,	Austin Brook,	.0055	.0055	.0068	.0004	.0006
Longmeadow,	Cooley Brook,	.0059	.0079	.0118	.0016	.0015
Pittsfield,	Mill Brook,	.0059	.0107	.0224	.0013	.0011
Northampton,	West Brook,	.0063	.0158	.0158	.0012	.0009

TABLE No. 6. — *Albuminoid Ammonia and Free Ammonia in the Water of Streams, arranged in Order of Albuminoid Ammonia* — Concluded.

[Parts per 100,000.]

CITY OR TOWN.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Westfield,	Tillotson Brook,	.0070	.0090	.0108	.0010	.0011
Pittsfield,	Hathaway Brook,	.0074	.0109	.0160	.0008	.0020
North Adams,	Broad Brook,	.0085	.0146	.0204	.0012	.0019
Easthampton,	Bassett Brook,	.0089	.0158	.0278	.0019	.0011
Adams,	Dry Brook,	.0090	.0129	.0194	.0010	.0013
Pittsfield,	Sacket Brook,	.0093	.0144	.0310	.0013	.0024
Lee,	Codding Brook,	.0095	.0126	.0166	.0008	.0014
Lawrence,	Merrimack River, filtered,	.0097	.0138	.0172	.0009	.0124
Milford,	Charles River, filtered,	.0100	.0161	.0168	-	.0018
Huntington,	Cold Brook,	.0126	.0177	.0190	.0015	.0015
Holyoke,	Manhan River,	.0133	.0196	.0276	.0022	.0014
Chicopee,	Cooley Brook,	.0139	.0228	.0336	.0024	.0019
Pittsfield,	Ashley Brook,	.0157	.0216	.0256	.0022	.0052
Springfield,	Ludlow canal,	.0158	.0276	.0440	.0025	.0023
Metropolitan Water District,	Nashua River,*	.0168	.0222	.0306	.0025	.0021
Lynn,	Saugus River,	.0331	.0499	.0584	.0037	.0050

* Affected by construction of Wachusett Reservoir.

TABLE No. 7. — *Albuminoid Ammonia and Free Ammonia in the Water of Lakes and Ponds, arranged in Order of Albuminoid Ammonia.*

[Parts per 100,000.]

CITY OR TOWN.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Montague,	Lake Pleasant,	.0077	.0098	.0118	.0011	.0018
Wareham,	Jonathan's Pond,	.0098	.0124	.0200	.0011	.0011
Falmouth,	Long Pond,	.0099	.0127	.0184	.0009	.0014

TABLE No. 7.— *Albuminoid Ammonia and Free Ammonia in the Water of Lakes and Ponds, arranged in Order of Albuminoid Ammonia* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Maynard,	White Pond,	.0119	.0162	.0248	.0019	.0006
Spencer,	Shaw Pond,	.0125	.0154	.0188	.0009	.0013
Hingham,	Accord Pond,	.0128	.0152	.0180	.0013	.0010
Concord,	Sandy Pond,	.0131	.0156	.0210	.0014	.0011
Brockton,	Silver Lake,	.0136	.0208	.0286	.0018	.0010
Fitchburg,	Meetinghouse Pond,	.0136	.0171	.0198	.0019	.0016
Rutland,	Muschopauge Lake,	.0136	.0174	.0250	.0018	.0023
Peabody,	Spring Pond,	.0138	.0150	.0166	.0025	.0062
Plymouth,	Little South Pond,	.0139	.0169	.0204	.0019	.0012
Haverhill,	Kenoza Lake,	.0149	.0167	.0176	.0016	.0013
Hudson,	Gates Pond,	.0151	.0184	.0230	.0019	.0028
Andover,	Haggett's Pond,	.0152	.0171	.0192	.0012	.0014
Abington,	Big Sandy Pond,	.0157	.0188	.0226	.0018	.0022
Stockbridge,	Lake Averic,	.0158	.0200	.0226	.0023	.0023
Haverhill,	Pentucket Lake,	.0160	.0186	.0244	.0019	.0010
Taunton,	Elder's Pond,	.0160	.0190	.0206	.0022	.0011
Haverhill,	Johnson's Pond,	.0166	.0200	.0266	.0016	.0012
Haverhill,	Crystal Lake,	.0166	.0192	.0216	.0019	.0013
New Bedford,	Little Quittacas Pond,	.0169	.0196	.0244	.0022	.0015
Peabody,	Brown's Pond,	.0169	.0201	.0222	.0027	.0015
Gardner,	Crystal Lake,	.0173	.0210	.0248	.0028	.0025
Randolph,	Great Pond,	.0174	.0206	.0236	.0013	.0012
Norwood,	Buckmaster Pond,	.0176	.0234	.0322	.0030	.0073
Fall River,	North Watuppa Lake,	.0180	.0216	.0252	.0025	.0013
New Bedford,	Great Quittacas Pond,	.0180	.0208	.0268	.0026	.0017
Taunton,	Assawompsett Pond,	.0183	.0233	.0340	.0026	.0021
Natick,	Dug Pond,	.0187	.0213	.0242	.0024	.0077
Salem,	Wenham Lake,	.0187	.0258	.0292	.0039	.0047
Weymouth,	Great Pond,	.0189	.0214	.0248	.0020	.0023
North Andover,	Great Pond,	.0190	.0228	.0272	.0026	.0022
Danvers,	Middleton Pond,	.0193	.0222	.0250	.0025	.0017
Springfield,	Chapin Pond,	.0193	.0216	.0254	.0030	.0010

TABLE No. 7. — *Albuminoid Ammonia and Free Ammonia in the Water of Lakes and Ponds, arranged in Order of Albuminoid Ammonia* — Concluded.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Wakefield,	Crystal Lake,	.0196	.0231	.0280	.0032	.0044
Metropolitan Water District,	Lake Cochituate,	.0208	.0271	.0308	.0033	.0030
Springfield,	Five Mile Pond,	.0210	.0262	.0364	.0025	.0058
Pittsfield,	Ashley Lake,	.0219	.0310	.0312	.0046	.0030
Marlborough,	Lake Williams,	.0225	.0260	.0292	.0041	.0022
Cambridge,	Fresh Pond,	.0227	.0358	.0578	.0055	.0053
Nantucket,	Wannacomet Pond,	.0237	.0573	.1540	.0091	.0037
Rockport,	Cape Pond,	.0301	.0430	.0584	.0090	.0114

TABLE No. 8. — *Albuminoid Ammonia and Free Ammonia in the Water of Storage Reservoirs, arranged in Order of Albuminoid Ammonia.*

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Greenfield,	Glen Brook Reservoir,	.0038	.0060	.0072	.0002	.0007
Hatfield,	Reservoir,	.0059	.0132	.0276	.0007	.0016
Great Barrington,	East Mountain Reservoir,	.0075	.0096	.0108	.0020	.0059
Northfield,	Reservoir,	.0077	.0118	.0164	.0009	.0006
Northampton,	Mountain Street Reservoir,	.0090	.0120	.0122	.0017	.0016
North Adams,	Notch Brook Reservoir,	.0101	.0161	.0240	.0022	.0047
Dalton,	Egypt Brook Reservoir,	.0110	.0128	.0158	.0015	.0014
Worcester,	Lower Holden Reservoir,	.0116	.0149	.0162	.0031	.0032
Northbridge,	Cook Allen Reservoir,	.0119	.0155	.0192	.0018	.0021
Lenox,	Reservoir,	.0122	.0173	.0220	.0030	.0015
Northampton,	Middle Reservoir,	.0127	.0216	.0260	.0024	.0013
South Hadley,	Buttery Brook Reservoir,	.0136	.0180	.0200	.0043	.0039

TABLE No. 8. — *Albuminoid Ammonia and Free Ammonia in the Water of Storage Reservoirs, arranged in Order of Albuminoid Ammonia* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia.				Free Ammonia, Average for Five Years.
		Total.			Suspended, Average for Five Years.	
		Average for Five Years.	Average of the Maxima for Five Years.	Maximum during Five Years.		
South Hadley,	Leaping Well Reservoir,	.0138	.0196	.0262	.0045	.0027
Amherst,	Amethyst Brook Reservoir,	.0143	.0201	.0364	.0015	.0021
Palmer,	Lower Reservoir,	.0148	.0209	.0350	.0026	.0010
Leominster,	Fall Brook Reservoir,	.0152	.0184	.0198	.0028	.0013
Worcester,	Leicester Reservoir,	.0153	.0181	.0200	.0021	.0041
Worcester,	Upper Holden Reservoir,	.0153	.0227	.0268	.0042	.0025
Metropolitan Water District,	Wachusett Reservoir,	.0154	.0192	.0192	.0031	.0034
Metropolitan Water District,	Sudbury Reservoir,	.0156	.0207	.0242	.0024	.0032
Metropolitan Water District,	Framingham Reservoir No. 3,	.0156	.0206	.0284	.0025	.0023
Holyoke,	Wright and Ashley Pond,	.0166	.0215	.0238	.0032	.0025
Williamstown,	Flora Glen Reservoir,	.0168	.0249	.0446	.0048	.0025
Southbridge,	Hatchet Brook Reservoir,	.0174	.0261	.0316	.0035	.0025
West Springfield,	Darby Brook Reservoir,	.0180	.0255	.0300	.0072	.0059
Gloucester,	Dike's Brook Reservoir,	.0186	.0241	.0300	.0032	.0030
Worcester,	Kent Reservoir,	.0188	.0276	.0324	.0033	.0031
Fitchburg,	Scott Reservoir,	.0192	.0265	.0332	.0056	.0057
Westfield,	Montgomery Reservoir,	.0192	.0246	.0356	.0036	.0032
Ipswich,	Dow's Brook Reservoir,	.0196	.0269	.0308	.0026	.0022
Leominster,	Morse Reservoir,	.0198	.0249	.0316	.0045	.0032
Metropolitan Water District,	Ashland Reservoir,	.0205	.0242	.0294	.0030	.0021
Haverhill,	Millvale Reservoir,	.0207	.0248	.0296	.0022	.0017
Lynn,	Breed's Reservoir,	.0208	.0269	.0308	.0034	.0039
Metropolitan Water District,	Hopkinton Reservoir,	.0210	.0267	.0302	.0029	.0033
Hinsdale,	Storage Reservoir,	.0210	.0299	.0300	.0076	.0044
Athol,	Buckman Brook Reservoir,	.0212	.0328	.0432	.0043	.0096
Gloucester,	Haskell Brook Reservoir,	.0212	.0353	.0398	.0058	.0053
Winchester,	South Reservoir,	.0214	.0260	.0302	.0028	.0054
Northborough,	Lower Reservoir,	.0220	.0295	.0352	.0040	.0029
Metropolitan Water District,	Framingham Reservoir No. 2,	.0226	.0297	.0372	.0024	.0032
Gloucester,	Wallace Reservoir,	.0229	.0301	.0384	.0060	.0037
Winchester,	North Reservoir,	.0232	.0298	.0432	.0048	.0040

TABLE NO. 8.—*Albuminoid Ammonia and Free Ammonia in the Water of Storage Reservoirs, arranged in Order of Albuminoid Ammonia*— Concluded.

[Parts per 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for Five Years.	Albuminoid Ammonia. Total. Average of the Maxima for Five Years.	Albuminoid Ammonia. Total. Maximum during Five Years.	Albuminoid Ammonia. Suspended, Average for Five Years.	Free Ammonia, Average for Five Years.
Brockton,	Salisbury Brook Reservoir,	.0233	.0308	.0336	.0036	.0019
Cambridge,	Stony Brook Reservoir,	.0234	.0290	.0306	.0033	.0030
Holyoke,	Whiting Street Reservoir,	.0237	.0362	.0514	.0069	.0026
Lynn,	Birch Reservoir,	.0245	.0345	.0482	.0043	.0051
North Brookfield,	Doane Pond,	.0246	.0331	.0428	.0047	.0065
Lynn,	Hawkes Reservoir,	.0248	.0344	.0424	.0034	.0084
Marlborough,	Millham Brook Reservoir,	.0258	.0335	.0436	.0057	.0054
New Bedford,	Old Storage Reservoir,	.0264	.0376	.0580	.0041	.0085
Cambridge,	Lower Hobbs Brook Reservoir,	.0265	.0319	.0358	.0045	.0029
North Brookfield,	North Pond,	.0271	.0357	.0444	.0058	.0056
Lee,	Upper Reservoir on Codding Brook.	.0278	.0397	.0494	.0069	.0070
Lynn,	Walden Reservoir,	.0286	.0366	.0444	.0066	.0084
Lynn,	Glen Lewis Reservoir,	.0291	.0483	.0860	.0084	.0062
Springfield,	Ludlow Reservoir,	.0301	.1121	.2670	.0120	.0042
Salem,	Longham Reservoir,	.0309	.0479	.0575	.0047	.0085
Whitman,	Hobart's Pond,	.0318	.0399	.0420	.0041	.0057
Leominster,	Haynes Reservoir,	.0319	.0429	.0575	.0108	.0047
Wayland,	Snake Brook Reservoir,	.0321	.0338	.0558	.0037	.0045
Winchester,	Middle Reservoir,	.0323	.0456	.0698	.0072	.0081
Athol,	Phillipston Reservoir,	.0334	.0575	.1300	.0110	.0049
Barre,	Reservoir,	.0365	.0365	.0366	.0070	.0100

The quantity of free ammonia present in the various surface-water supplies of the State is, for the most part, small, and its presence is due to various causes. Free ammonia is a characteristic ingredient of sewage, and in sewage polluted waters it is present in large quantities; but free ammonia is a product of decay, and there are many conditions which cause its development or disappearance in surface waters. Some of the deeper lakes and ponds show a decided increase in free ammonia in the late fall or early winter, due to the accumulation of ammonia during the warm weather in the lower stagnant layers, which is distributed

throughout the water as the coming of cold weather puts these deeper layers into circulation. In ponds and reservoirs in which there are excessive growths of organisms, such as the Middle Reservoir at Winchester, the Barre Reservoir and Cape Pond, Rockport, free ammonia is present frequently in large quantity. The quantity of free ammonia present in the various surface-water supplies is given in Table No. 9, and the quantity in the streams, ponds and reservoirs separately is given in tables Nos. 10, 11 and 12.

TABLE No. 9. — *Free Ammonia in Surface Waters.*

[Parts per 100,000.]

Williamstown, Paul Brook,	.0003
Adams, Bassett Brook,	.0005
Chester, Austin Brook,	.0006
Chicopee, Morton Brook,	.0006
Northfield, reservoir,	.0006
Greenfield, Glen Brook Reservoir,	.0007
Maynard, White Pond,	.0008
Cheshire, Thunder Brook,	.0009
Deerfield, Roaring Brook,	.0009
Northampton, West Brook,	.0009
Metropolitan Water District, tap in Quincy,	.0010
Brockton, Silver Lake,	.0010
Haverhill, Pentucket Lake,	.0010
Hingham, Accord Pond,	.0010
Palmer, Lower Reservoir,	.0010
Springfield, Chapin Pond,	.0010
Concord, Sandy Pond,	.0011
Easthampton, Bassett Brook,	.0011
Pittsfield, Mill Brook,	.0011
Taunton, Elder's Pond,	.0011
Wareham, Jonathan's Pond,	.0011
Westfield, Tillotson Brook,	.0011
Great Barrington, Green River,	.0012
Haverhill, Johnson's Pond,	.0012
Plymouth, Little South Pond,	.0012
Randolph, Great Pond,	.0012
Adams, Dry Brook,	.0013
Cheshire, Kitchen Brook,	.0013
Fall River, North Watuppa Lake,	.0013
Haverhill, Crystal Lake,	.0013
Haverhill, Kenoza Lake,	.0013
Leominster, Fall Brook Reservoir,	.0013
Northampton, Middle Reservoir,	.0013
Spencer, Shaw Pond,	.0013
Metropolitan Water District, tap in Revere,	.0014
Andover, Haggett's Pond,	.0014
Dalton, Egypt Brook Reservoir,	.0014
Falmouth, Long Pond,	.0014
Holyoke, Manhan River,	.0014
Lee, Codding Brook,	.0014
Metropolitan Water District, tap in State House,	.0015
Huntington, Cold Brook,	.0015
Lenox, reservoir,	.0015
Longmeadow, Cooley Brook,	.0015
New Bedford, Little Quittacas Pond,	.0015
Peabody, Brown's Pond,	.0015
Fitchburg, Meetinghouse Pond,	.0016
Hatfield, reservoir,	.0016
New Bedford, tap in City Hall,	.0016
Northampton, Mountain Street Reservoir,	.0016
Danvers, Middleton Pond,	.0017
Haverhill, Millvale Reservoir,	.0017
New Bedford, Great Quittacas Pond,	.0017
Metropolitan Water District, Spot Pond,	.0018
Milford, Charles River, filtered,	.0018
Montague, Lake Pleasant,	.0018
Brockton, Salisbury Brook Reservoir,	.0019
Chicopee, Cooley Brook,	.0019
North Adams, Broad Brook,	.0019
Pittsfield, Hathaway Brook,	.0020

TABLE No. 9. — *Free Ammonia in Surface Waters* — Continued.

[Parts per 100,000.]

Metropolitan Water District, Nashua River,	.0021
Metropolitan Water District, Ashland Reservoir,	.0021
Amherst, Amethyst Brook Reservoir,	.0021
Northbridge, Cook Allen Reservoir,	.0021
Taunton, Assawompsett Pond,	.0021
Abington, Big Sandy Pond,	.0022
Ipswich, Dow's Brook Reservoir,	.0022
Marlborough, Lake Williams,	.0022
North Andover, Great Pond,	.0022
Worcester, Lower Holden Reservoir,	.0022
Metropolitan Water District, Framingham Reservoir No. 3,	.0023
Rutland, Muschopauge Lake,	.0023
Springfield, Ludlow Canal,	.0023
Stockbridge, Lake Averic,	.0023
Weymouth, Great Pond,	.0023
Pittsfield, Sacket Brook,	.0024
Metropolitan Water District, Chestnut Hill Reservoir,	.0025
Gardner, Crystal Lake,	.0025
Holyoke, Wright and Ashley Pond,	.0025
Southbridge, Hatchet Brook Reservoir,	.0025
Williamstown, Flora Glen Reservoir,	.0025
Worcester, Upper Holden Reservoir,	.0025
Athol, Buckman Brook Reservoir,	.0026
Holyoke, Whiting Street Reservoir,	.0026
South Hadley, Leaping Well Reservoir,	.0027
Hudson, Gates Pond,	.0028
Cambridge, Lower Hobbs Brook Reservoir,	.0029
Northborough, Lower Reservoir,	.0029
Metropolitan Water District, Lake Cochituate,	.0030
Cambridge, Stony Brook Reservoir,	.0030
Gloucester, Dike's Brook Reservoir,	.0030
Lynn, tap,	.0030
Worcester, Kent Reservoir,	.0031
Metropolitan Water District, Framingham Reservoir No. 2,	.0032
Metropolitan Water District, Sudbury Reservoir,	.0032
Leominster, Morse Reservoir,	.0032
Westfield, Montgomery Reservoir,	.0032
Metropolitan Water District, Hopkinton Reservoir,	.0033
Metropolitan Water District, Wachusett Reservoir,	.0034
Lynn, Walden Reservoir,	.0034
Lynn, Hawkes Reservoir,	.0034
New Bedford, old storage reservoir,	.0035
Gloucester, Wallace Reservoir,	.0037
Nantucket, Wannacomet Pond,	.0037
Lynn, Breed's Reservoir,	.0039
South Hadley, Buttery Brook Reservoir,	.0039
Winchester, North Reservoir,	.0040
Worcester, Leicester Reservoir,	.0041
Springfield, Ludlow Reservoir,	.0042
Hinsdale, storage reservoir,	.0044
Wakefield, Crystal Lake,	.0044
Wayland, Snake Brook Reservoir,	.0045
Leominster, Haynes Reservoir,	.0047
North Adams, Notch Brook Reservoir,	.0047
Salem, Wenham Lake,	.0047
Athol, Phillipston Reservoir,	.0049
Lynn, Saugus River,	.0050
Lynn, Birch Reservoir,	.0051
Pittsfield, Ashley Brook,	.0052
Cambridge, Fresh Pond,	.0053
Gloucester, Haskell Brook Reservoir,	.0053
Marlborough, Millham Brook Reservoir,	.0054
Winchester, South Reservoir,	.0054
North Brookfield, North Pond,	.0056
Fitchburg, Scott Reservoir,	.0057
Whitman, Hobart's Pond,	.0057

TABLE NO. 9. — *Free Ammonia in Surface Waters* — Concluded.

[Parts per 100,000.]

Springfield, Five Mile Pond,	.0058	Norwood, Buckmaster Pond,	.0073
Great Barrington, East Mountain Reservoir,	.0059	Natick, Dug Pond,	.0077
West Springfield, Darby Brook Reservoir,	.0059	Pittsfield, Ashley Lake,	.0080
Lynn, Glen Lewis Reservoir,	.0062	Winchester, Middle Reservoir,	.0081
Peabody, Spring Pond,	.0062	Salem, Longham Reservoir,	.0085
North Brookfield, Doane Pond,	.0065	Barre, reservoir,	.0100
Lee, Upper Reservoir on Codding Brook,	.0070	Rockport, Cape Pond,	.0114
		Lawrence, Merrimack River, filtered,	.0124

TABLE NO. 10. — *Free Ammonia in the Water of Streams.*

[Parts per 100,000.]

Williamstown, Paul Brook,	.0003	Lee, Codding Brook,	.0014
Adams, Bassett Brook,	.0005	Huntington, Cold Brook,	.0015
Chester, Austin Brook,	.0006	Longmeadow, Cooley Brook,	.0015
Chicopee, Morton Brook,	.0006	Milford, Charles River, filtered,	.0018
Cheshire, Thunder Brook,	.0009	Chicopee, Cooley Brook,	.0019
Deerfield, Roaring Brook,	.0009	North Adams, Broad Brook,	.0019
Northampton, West Brook,	.0009	Pittsfield, Hathaway Brook,	.0020
Easthampton, Bassett Brook,	.0011	Metropolitan Water District, Nashua River,*	.0021
Pittsfield, Mill Brook,	.0011	Springfield, Ludlow Canal,	.0023
Westfield, Tillotson Brook,	.0011	Pittsfield, Sacket Brook,	.0024
Great Barrington, Green River,	.0012	Lynn, Saugus River,†	.0050
Adams, Dry Brook,	.0013	Pittsfield, Ashley Brook,‡	.0052
Cheshire, Kitchen Brook,	.0013	Lawrence, Merrimack River, filtered,§	.0124
Holyoke, Manhan River,	.0014		

TABLE NO. 11. — *Free Ammonia in the Water of Lakes and Ponds.*

[Parts per 100,000.]

Maynard, White Pond,	.0008	Wareham, Jonathan's Pond,	.0011
Brockton, Silver Lake,	.0010	Haverhill, Johnson's Pond,	.0012
Haverhill, Pentucket Lake,	.0010	Plymouth, Little South Pond,	.0012
Hingham, Accord Pond,	.0010	Randolph, Great Pond,	.0012
Springfield, Chapin Pond,	.0010	Fall River, North Watuppa Lake,	.0013
Concord, Sandy Pond,	.0011	Haverhill, Crystal Lake,	.0013
Taunton, Elder's Pond,	.0011	Haverhill, Kenoza Lake,	.0013

* Affected by construction of Wachusett Reservoir.

† Free ammonia due to sewage pollution.

‡ This stream is fed largely by water drawn from Ashley Lake.

§ Probably derived in part from the pollution of the river water by sewage and in part from ground water, which enters the filtered water well.

TABLE NO. 11.—*Free Ammonia in the Water of Lakes and Ponds*—Concluded.

[Parts per 100,000.]

Spencer, Shaw Pond,	.0013
Andover, Haggett's Pond,	.0014
Falmouth, Long Pond,	.0014
New Bedford, Little Quittacas Pond,	.0015
Peabody, Brown's Pond,	.0015
Fitchburg, Meetinghouse Pond,	.0016
Danvers, Middleton Pond,	.0017
New Bedford, Great Quittacas Pond,	.0017
Montague, Lake Pleasant,	.0018
Taunton, Assawompsett Pond,	.0021
Abington, Big Sandy Pond,	.0022
Marlborough, Lake Williams,	.0022
North Andover, Great Pond,	.0022
Rutland, Muschopauge Lake,	.0023
Stockbridge, Lake Averic,	.0023
Weymouth, Great Pond,	.0023
Gardner, Crystal Lake,	.0025
Hudson, Gates Pond,	.0028
Metropolitan Water District, Lake Cochituate,	.0030
Nantucket, Wannacomet Pond,	.0037
Wakefield, Crystal Lake,	.0044
Salem, Wenham Lake,	.0047
Cambridge, Fresh Pond,	.0053
Springfield, Five Mile Pond,	.0058
Peabody, Spring Pond,	.0062
Norwood, Buckmaster Pond,	.0073
Natick, Dug Pond,	.0077
Pittsfield, Ashley Lake,	.0080
Rockport, Cape Pond,	.0114

TABLE NO. 12.—*Free Ammonia in the Water of Storage Reservoirs.*

[Parts per 100,000.]

Northfield, reservoir,	.0006
Greenfield, Glen Brook Reservoir,	.0007
Palmer, Lower Reservoir,	.0010
Leominster, Fall Brook Reservoir,	.0013
Northampton, Middle Reservoir,	.0013
Dalton, Egypt Brook Reservoir,	.0014
Lenox, reservoir,	.0015
Hatfield, reservoir,	.0016
Northampton, Mountain Street Reservoir,	.0016
Haverhill, Millvale Reservoir,	.0017
Brockton, Salisbury Brook Reservoir,	.0019
Metropolitan Water District, Ashland Reservoir,	.0021
Amherst, Amethyst Brook Reservoir,	.0021
Northbridge, Cook Allen Reservoir,	.0021
Ipswich, Dow's Brook Reservoir,	.0022
Worcester, Lower Holden Reservoir,	.0022
Metropolitan Water District, Framingham Reservoir No. 3,	.0023
Holyoke, Wright and Ashley Pond,	.0025
Southbridge, Hatchet Brook Reservoir,	.0025
Williamstown, Flora Glen Reservoir,	.0025
Worcester, Upper Holden Reservoir,	.0025
Athol, Buckman Brook Reservoir,	.0026
Holyoke, Whiting Street Reservoir,	.0026
South Hadley, Leaping Well Reservoir,	.0027
Cambridge, Lower Hobbs Brook Reservoir,	.0029
Northbridge, Lower Reservoir,	.0029
Cambridge, Stony Brook Reservoir,	.0030
Gloucester, Dike's Brook Reservoir,	.0030
Worcester, Kent Reservoir,	.0031
Metropolitan Water District, Framingham Reservoir No. 2,	.0032
Metropolitan Water District, Sudbury Reservoir,	.0032
Leominster, Morse Reservoir,	.0032
Westfield, Montgomery Reservoir,	.0032
Metropolitan Water District, Hopkinton Reservoir,	.0033
Metropolitan Water District, Wachusett Reservoir,	.0034
Lynn, Walden Reservoir,	.0034

TABLE NO. 12. — *Free Ammonia in the Water of Storage Reservoirs* — Concluded.

[Parts per 100,000.]

Lynn, Hawkes Reservoir,	.0034	Marlborough, Millham Brook Reservoir,	.0054
New Bedford, old storage reservoir,	.0035	Winchester, South Reservoir,	.0054
Gloucester, Wallace Reservoir,	.0037	North Brookfield, North Pond,	.0056
Lynn, Breed's Reservoir,	.0039	Fitchburg, Scott Reservoir,	.0057
South Hadley, Buttery Brook Reservoir,	.0039	Whitman, Hobart's Pond,	.0057
Winchester, North Reservoir,	.0040	Great Barrington, East Mountain Reservoir,	.0059
Worcester, Leicester Reservoir,	.0041	West Springfield, Darby Brook Reservoir,	.0059
Springfield, Ludlow Reservoir,	.0042	Lynn, Glen Lewis Reservoir,	.0062
Hinsdale, storage reservoir,	.0044	North Brookfield, Doane Pond,	.0065
Wayland, Snake Brook Reservoir,	.0045	Lee, Upper Reservoir on Codding Brook,	.0070
Leominster, Haynes Reservoir,	.0047	Winchester, Middle Reservoir,	.0081
North Adams, Notch Brook Reservoir,	.0047	Salem, Longham Reservoir,	.0085
Athol, Phillipston Reservoir,	.0049	Barre, reservoir,	.0100
Lynn, Birch Reservoir,	.0051		
Gloucester, Haskell Brook Reservoir,	.0053		

ODORS OF SURFACE WATERS.

Practically all surface waters have at times a noticeable odor. The odors of the waters of unpolluted streams derived from a country for the most part free from swamps are generally slight, and where such waters are passed through a reservoir of small capacity in proportion to the flow of the stream they may be nearly always odorless. Waters derived from swampy areas usually have a noticeably vegetable odor. The waters of nearly all ponds and storage reservoirs are affected at times by growths of organisms which give to the water noticeable tastes and odors, which are sometimes unpleasant or disagreeable. The waters of some ponds are affected in this way only slightly and at infrequent intervals. In other cases the waters are affected at certain seasons of the year, though not in every year, while in a few cases the waters are affected in every year in a more or less serious degree. Some of the waters are so badly affected by disagreeable taste and odor that they are at times unfit for domestic use.

In the following table the waters of the various sources are grouped in accordance with the frequency and intensity of the odors which have been recorded from the observations of the past five years. For convenience, the groups have been divided so as to show the comparative odors of the waters of streams, ponds and artificial storage reservoirs.

TABLE No. 13. — *Odors of Surface Waters.*

GROUP I. — *Waters which are Odorless or which have Occasional Faint Odors.*

City or Town.	Source.	City or Town.	Source.
Adams, . . .	Bassett Brook.	Milford, . . .	Charles River, filtered.
Adams, . . .	Dry Brook.	North Adams, . .	Broad Brook.
Brockton, . . .	Silver Lake.	North Adams, . .	Notch Brook Reservoir.
Cheshire, . . .	Kitchen Brook.	Northampton, . .	Mountain Street Reservoir.
Cheshire, . . .	Thunder Brook.	Northampton, . .	West Brook.
Chester, . . .	Austin Brook.	Northfield, . . .	Reservoir.
Chicopee, . . .	Morton Brook.	Pittsfield, . . .	Ashley Brook.
Dalton, . . .	Egypt Brook Reservoir.	Pittsfield, . . .	Hathaway Brook.
Deerfield, . . .	Roaring Brook.	Pittsfield, . . .	Mill Brook.
Easthampton, . .	Bassett Brook.	Pittsfield, . . .	Sacket Brook.
Falmouth, . . .	Long Pond.	Rutland, . . .	Muschopauge Lake.
Great Barrington, .	East Mountain Reservoir.	Spencer, . . .	Shaw Pond.
Great Barrington, .	Green River.	Westfield, . . .	Tillotson Brook.
Greenfield, . . .	Glen Brook Reservoir.	Williamstown, . .	Flora Glen Reservoir.
Huntington, . .	Cold Brook.	Williamstown, . .	Paul Brook.
Lee, ...	Codding Brook.	Worcester, . . .	Lower Holden Reservoir.
Longmeadow, . .	Cooley Brook.		

GROUP II. — *Waters which are usually Odorless but have occasionally a Distinct and at Times an Unpleasant Odor.*

City or Town.	Source.	City or Town.	Source.
Metropolitan Water District.	Nashua River.	Holyoke, . . .	Manhan River.
Metropolitan Water District.	Sudbury Reservoir.	Hudson, . . .	Gates Pond.
Amherst, . . .	Amethyst Brook Reservoir.	Lee, ...	Upper Reservoir on Codding Brook.
Andover, . . .	Haggett's Pond.	Lenox, ...	Reservoir.
Athol, ...	Buckman Brook Reservoir.	Lynn, ...	Hawkes Reservoir.
Barre, ...	Reservoir.	Maynard, . . .	White Pond.
Chicopee, . . .	Cooley Brook.	Montague, . . .	Lake Pleasant.
Concord, . . .	Sandy Pond.	New Bedford, . .	Little Quittacas Pond.
Fall River, . . .	North Watuppa Lake.	Northampton, . .	Middle Reservoir.
Fitchburg, . . .	Meetinghouse Pond.	North Andover, . .	Great Pond.
Gardner, . . .	Crystal Lake.	Northbridge, . .	Cook Allen Reservoir.
Hatfield, . . .	Reservoir.	Palmer, . . .	Lower Reservoir.
Haverhill, . . .	Crystal Lake.	Pittsfield, . . .	Ashley Lake.
Haverhill, . . .	Johnson's Pond.	Plymouth, . . .	Little South Pond.
Haverhill, . . .	Pentucket Lake.	Randolph, . . .	Great Pond.
Hingham, . . .	Accord Pond.	Southbridge, . .	Hatchet Brook Reservoir.

TABLE No. 13. — *Odors of Surface Waters* — Continued.

GROUP II. — *Waters which are usually Odorless but have occasionally a Distinct and at Times an Unpleasant Odor* — Concluded.

City or Town.	Source.	City or Town.	Source.
South Hadley, . .	Leaping Well Reservoir.	Westfield, . . .	Montgomery Reservoir.
Taunton, . . .	Elder's Pond.	Worcester, . . .	Kent Reservoir.
Taunton, . . .	Assawompsett Pond.	Worcester, . . .	Upper Holden Reservoir.
Wareham, . . .	Jonathan's Pond.	Worcester, . . .	Leicester Reservoir.

GROUP III. — *Waters which have frequently a Noticeable and at Times a Distinct or Unpleasant Odor.*

Metropolitan Water District.	Wachusett Reservoir.	Lawrence, . . .	Merrimack River, filtered.
Metropolitan Water District.	Lake Cochituate.	Leominster, . .	Fall Brook Reservoir.
Metropolitan Water District.	Framingham Reservoir No. 2.	Leominster, . .	Morse Reservoir.
Metropolitan Water District.	Framingham Reservoir No. 3.	New Bedford, . .	Great Quittacas Pond.
Metropolitan Water District.	Ashland Reservoir.	North Brookfield, .	North Pond.
Metropolitan Water District.	Hopkinton Reservoir.	Norwood, . . .	Buckmaster Pond.
Abington, . . .	Big Sandy Pond.	Peabody, . . .	Brown's Pond.
Cambridge, . . .	Lower Hobbs Brook Reservoir.	Peabody, . . .	Spring Pond.
Danvers, . . .	Middleton Pond.	Salem, ...	Wenham Lake.
Fitchburg, . . .	Scott Reservoir.	South Hadley, . .	Buttery Brook Reservoir.
Gloucester, . . .	Haskell Brook Reservoir.	Springfield, . . .	Five Mile Pond.
Haverhill, . . .	Millvale Reservoir.	Springfield, . . .	Chapin Pond.
Haverhill, . . .	Kenoza Lake.	Stockbridge, . .	Lake Averic.
Holyoke, . . .	Wright and Ashley Pond.	Wakefield, . . .	Crystal Lake.
Ipswich, . . .	Dow's Brook Reservoir.	Weymouth, . . .	Great Pond.

GROUP IV. — *Waters which have generally a Noticeable Odor which is frequently Unpleasant or Disagreeable.*

Brockton, . . .	Salisbury Brook Reservoir.	Marlborough, . .	Millham Brook Reservoir.
Cambridge, . . .	Fresh Pond.	Nantucket, . . .	Wannacomet Pond.
Cambridge, . . .	Stony Brook Reservoir.	Natick, ...	Dug Pond.
Gloucester, . . .	Wallace Reservoir.	New Bedford, . .	Old storage reservoir.
Gloucester, . . .	Dike's Brook Reservoir.	Northborough, . .	Lower Reservoir.
Holyoke, . . .	Whiting Street Reservoir.	North Brookfield, .	Doane Pond.
Leominster, . .	Haynes Reservoir.	Rockport, . . .	Cape Pond.
Lynn, ...	Birch Reservoir.	Wayland, . . .	Snake Brook Reservoir.
Lynn, ...	Breed's Reservoir.	Winchester, . .	North Reservoir.
Lynn, ...	Saugus River.	Winchester, . .	South Reservoir.
Marlborough, . .	Lake Williams.		

TABLE No. 13. — *Odors of Surface Waters* — Concluded.

GROUP V. — *Waters which have generally a Strong and frequently an Unpleasant or Disagreeable Odor.*

City or Town.	Source.	City or Town.	Source.
Athol, ...	Phillipston Reservoir.	Springfield, . . .	Ludlow Reservoir.
Hinsdale, . . .	Storage Reservoir.	Springfield, . . .	Ludlow Canal.
Lynn, ...	Walden Reservoir.	West Springfield, .	Darby Brook Reservoir.
Lynn, ...	Glen Lewis Reservoir.	Whitman, . . .	Hobart's Pond.
Salem, ...	Longham Reservoir.	Winchester, . .	Middle Reservoir.

TABLE No. 14. — *Odors of the Water of Streams.*

GROUP I. — *Waters which are Odorless or which have Occasional Faint Odors.*

City or Town.	Source.	City or Town.	Source.
Adams, . . .	Bassett Brook.	Longmeadow, . .	Cooley Brook.
Adams, . . .	Dry Brook.	Milford, . . .	Charles River, filtered.
Cheshire, . . .	Kitchen Brook.	North Adams, . .	Broad Brook.
Cheshire, . . .	Thunder Brook.	Northampton, . .	West Brook.
Chester, . . .	Austin Brook.	Pittsfield, . . .	Ashley Brook.
Chicopee, . . .	Morton Brook.	Pittsfield, . . .	Hathaway Brook.
Deerfield, . . .	Roaring Brook.	Pittsfield, . . .	Mill Brook.
Easthampton, . .	Bassett Brook.	Pittsfield, . . .	Sacket Brook.
Great Barrington, .	Green River.	Westfield, . . .	Tillotson Brook.
Huntington, . .	Cold Brook.	Williamstown, . .	Paul Brook.
Lee, ...	Codding Brook.		

GROUP II. — *Waters which are usually Odorless but have occasionally a Distinct and at Times an Unpleasant Odor.*

Metropolitan Water District.	Nashua River.	Holyoke, . . .	Manhan River.
Chicopee, . . .	Cooley Brook.		

GROUP III. — *Waters which have frequently a Noticeable and at Times a Distinct or Unpleasant Odor.*

Lawrence, . . .	Merrimack River, filtered.	-	-

GROUP IV. — *Waters which have generally a Noticeable Odor which is frequently Unpleasant or Disagreeable.*

Lynn, ...	Saugus River.	-	-

TABLE NO. 14. — *Odors of the Water of Streams* — Concluded.

GROUP V. — *Waters which have generally a Strong and frequently an Unpleasant or Disagreeable Odor.*

CITY OR TOWN.	Source.	CITY OR TOWN.	Source.
Springfield, . . .	Ludlow Canal.	-	-

TABLE NO. 15. — *Odors of the Water of Lakes and Ponds.*

GROUP I. — *Waters which are Odorless or which have Occasional Faint Odors.*

CITY OR TOWN.	Source.	CITY OR TOWN.	Source.
Brockton, . . .	Silver Lake.	Rutland, . . .	Muschopauge Lake.
Falmouth, . . .	Long Pond.	Spencer, . . .	Shaw Pond.

GROUP II. — *Waters which are usually Odorless, but have occasionally a Distinct and at Times an Unpleasant Odor.*

Andover, . . .	Haggett's Pond.	Maynard, . . .	White Pond.
Concord, . . .	Sandy Pond.	Montague, . . .	Lake Pleasant.
Fall River, . . .	North Watuppa Lake.	New Bedford, . .	Little Quittacas Pond.
Fitchburg, . . .	Meetinghouse Pond.	North Andover, . .	Great Pond.
Gardner, . . .	Crystal Lake.	Pittsfield, . . .	Ashley Lake.
Haverhill, . . .	Crystal Lake.	Plymouth, . . .	Little South Pond.
Haverhill, . . .	Johnson's Pond.	Randolph, . . .	Great Pond.
Haverhill, . . .	Pentucket Lake.	Taunton, . . .	Elder's Pond.
Hingham, . . .	Accord Pond.	Taunton, . . .	Assawompsett Pond.
Hudson, . . .	Gates Pond.	Wareham, . . .	Jonathan's Pond.

GROUP III. — *Waters which have frequently a Noticeable and at Times a Distinct or Unpleasant Odor.*

Metropolitan Water District.	Lake Cochituate.	Peabody, . . .	Spring Pond.
Abington, . . .	Big Sandy Pond.	Salem, ...	Wenham Lake.
Danvers, . . .	Middleton Pond.	Springfield, . . .	Five Mile Pond.
Haverhill, . . .	Kenoza Lake.	Springfield, . . .	Chapin Pond.
New Bedford, . .	Great Quittacas Pond.	Stockbridge, . .	Lake Averic.
Norwood, . . .	Buckmaster Pond.	Wakefield, . . .	Crystal Lake.
Peabody, . . .	Brown's Pond.	Weymouth, . . .	Great Pond.

TABLE No. 15.— *Odors of the Water of Lakes and Ponds* — Concluded.

GROUP IV.— *Waters which have generally a Noticeable Odor which is frequently Unpleasant or Disagreeable.*

City or Town.	Source.	City or Town.	Source.
Cambridge, . . .	Fresh Pond.	Natick, ...	Dug Pond.
Marlborough, . .	Lake Williams.	Rockport, . . .	Cape Pond.
Nantucket, . . .	Wannacomet Pond.		

TABLE No. 16.— *Odors of the Water of Storage Reservoirs.*

GROUP I.— *Waters which are Odorless or which have Occasional Faint Odors.*

City or Town.	Source.	City or Town.	Source.
Dalton, ...	Egypt Brook Reservoir.	Northampton, . .	Mountain Street Reservoir.
Great Barrington, .	East Mountain Reservoir.	Northfield, . . .	Reservoir.
Greenfield, . . .	Glen Brook Reservoir.	Williamstown, . .	Flora Glen Reservoir.
North Adams, . .	Notch Brook Reservoir.	Worcester, . . .	Lower Holden Reservoir.

GROUP II.— *Waters which are Usually Odorless but have occasionally a Distinct and at Times an Unpleasant Odor.*

City or Town.	Source.	City or Town.	Source.
Metropolitan Water District.	Sudbury Reservoir.	Northbridge, . .	Cook Allen Reservoir.
Amherst, ...	Amethyst Brook Reservoir.	Palmer, ...	Lower Reservoir.
Athol, ...	Buckman Brook Reservoir.	Southbridge, . .	Hatchet Brook Reservoir.
Barre, ...	Reservoir.	South Hadley, . .	Leaping Well Reservoir.
Hatfield, ...	Reservoir.	Westfield, . . .	Montgomery Reservoir.
Lee, ...	Upper Reservoir on Codding Brook.	Worcester, . . .	Kent Reservoir.
Lenox, ...	Reservoir.	Worcester, . . .	Upper Holden Reservoir.
Lynn, ...	Hawkes Reservoir.	Worcester, . . .	Leicester Reservoir.
Northampton, . .	Middle Reservoir.		

GROUP III.— *Waters which have frequently a Noticeable and at times a Distinct or Unpleasant Odor.*

City or Town.	Source.	City or Town.	Source.
Metropolitan Water District.	Wachusett Reservoir.	Haverhill, . . .	Millvale Reservoir.
Metropolitan Water District.	Framingham Reservoir No. 2.	Holyoke, . . .	Wright and Ashley Pond.
Metropolitan Water District.	Framingham Reservoir No. 3.	Ipswich, . . .	Dow's Brook Reservoir.
Metropolitan Water District.	Ashland Reservoir.	Leominster, . .	Fall Brook Reservoir.
Metropolitan Water District.	Hopkinton Reservoir.	Leominster, . .	Morse Reservoir.
Cambridge, . . .	Lower Hobbs Brook Reservoir.	North Brookfield, .	North Pond.
Fitchburg, . . .	Scott Reservoir.	South Hadley, . .	Buttery Brook Reservoir.
Gloucester, . . .	Haskell Brook Reservoir.		

TABLE No. 16. — *Odors of the Water of Storage Reservoirs* — Concluded.

GROUP IV. — *Waters which have generally a Noticeable Odor which is frequently Unpleasant or Disagreeable.*

City or Town.	Source.	City or Town.	Source.
Brockton,	Salisbury Brook Reservoir.	Marlborough,	Millham Brook Reservoir.
Cambridge,	Stony Brook Reservoir.	New Bedford,	Old Storage Reservoir.
Gloucester,	Wallace Reservoir.	Northborough,	Lower Reservoir.
Gloucester,	Dike's Brook Reservoir.	North Brookfield,	Doane Pond.
Holyoke,	Whiting Street Reservoir.	Wayland,	Snake Brook Reservoir.
Leominster,	Haynes Reservoir.	Winchester,	North Reservoir.
Lynn,	Birch Reservoir.	Winchester,	South Reservoir.
Lynn,	Breed's Reservoir.		

GROUP V. — *Waters which have generally a Strong and frequently an Unpleasant or Disagreeable Odor.*

Athol,	Phillipston Reservoir.	Springfield,	Ludlow Reservoir.
Hinsdale,	Storage Reservoir.	West Springfield,	Darby Brook Reservoir.
Lynn,	Walden Reservoir.	Whitman,	Hobart's Pond.
Lynn,	Glen Lewis Reservoir.	Winchester,	Middle Reservoir.
Salem,	Longham Reservoir.		

Color of Surface Waters.

The contact of surface waters with vegetation enables them to take up coloring matter from the leaves, grasses, peat, etc., and long contact with vegetable matter in swamps imparts to some of the waters a very high color. Practically all of the surface waters used as sources of water supply in the State are more or less colored by vegetable matter. Waters derived from steep water-sheds, such as those of the mountain streams in the westerly part of the State, are for the most part nearly colorless, as are also the waters of streams which are fed largely by springs. The waters of some ponds and reservoirs, though receiving through their tributary streams waters having a high color, are nearly colorless, the color having been removed from the water by bleaching chiefly, due to exposure to sunlight for a long period.

The following table, No. 17, gives the average color of the various water supplies in the State in the last five years; and for convenience, this table has also been divided so as to show the comparative color of the waters of streams, natural ponds and storage reservoirs (Tables 18–20).

Table No. 17. — *Color of Surface Waters.*

[Parts per 100,000.]

Falmouth, Long Pond,	0.00
Cheshire, Thunder Brook,	0.01
Cheshire, Kitchen Brook,	0.01
Great Barrington, Green River,	0.01
Plymouth, Little South Pond,	0.01
Adams, Bassett Brook,	0.02
Chicopee, Morton Brook,	0.02
Concord, Sandy Pond,	0.02
Greenfield, Glen Brook Reservoir,	0.02
Montague, Lake Pleasant,	0.02
Wareham, Jonathan's Pond,	0.02
Williamstown, Paul Brook,	0.02
Deerfield, Roaring Brook,	0.03
North Adams, Notch Brook Reservoir,	0.03
Peabody, Spring Pond,	0.03
Pittsfield, Mill Brook,	0.03
South Hadley, Leaping Well Reservoir,	0.03
Spencer, Shaw Pond,	0.03
Haverhill, Pentucket Lake,	0.04
Maynard, White Pond,	0.04
Northampton, Mountain Street Reservoir,	0.04
Springfield, Chapin Pond,	0.04
Gardner, Crystal Lake,	0.05
Lenox, reservoir,	0.05
Pittsfield, Hathaway Brook,	0.05
Rutland, Muschopauge Lake,	0.05
Taunton, Elder's Pond,	0.05
Fitchburg, Meetinghouse Pond,	0.06
Longmeadow, Cooley Brook,	0.06
Metropolitan Water District, Spot Pond,	0.07
Barre, reservoir,	0.07
Chester, Austin Brook,	0.07
Nantucket, Wannacomet Pond,	0.07
Pittsfield, Sacket Brook,	0.07
Springfield, Five Mile Pond,	0.07
Williamstown, Flora Glen Reservoir,	0.07
Worcester, Lower Holden Reservoir,	0.07
Holyoke, Whiting Street Reservoir,	0.08
Hudson, Gates Pond,	0.08
Marlborough, Lake Williams,	0.08
Westfield, Tillotson Brook,	0.08
Winchester, North Reservoir,	0.08
Brockton, Silver Lake,	0.09
Haverhill, Kenoza Lake,	0.09
Holyoke, Wright and Ashley Pond,	0.09
Stockbridge, Lake Averic,	0.09
Winchester, South Reservoir,	0.09
Haverhill, Johnson's Pond,	0.10
Norwood, Buckmaster Pond,	0.10
Metropolitan Water District, tap in Revere,	0.11
Abington, Big Sandy Pond,	0.11
Hatfield, reservoir,	0.11
Leominster, Fall Brook Reservoir,	0.11
Great Barrington, East Mountain Reservoir,	0.12
North Andover, Great Pond,	0.12
Salem, Wenham Lake,	0.12
Andover, Haggett's Pond,	0.13
Cambridge, Lower Hobbs Brook Reservoir,	0.13
Natick, Dug Pond,	0.13
Northampton, West Brook,	0.13
Pittsfield, Ashley Brook,	0.14
West Springfield, Darby Brook Reservoir,	0.14
Worcester, Upper Holden Reservoir,	0.14
Fall River, North Watuppa Lake,	0.15
Peabody, Brown's Pond,	0.15
Fitchburg, Scott Reservoir,	0.16
Haverhill, Crystal Lake,	0.16
North Adams, Broad Brook,	0.16
Northfield, reservoir,	0.16
Wakefield, Crystal Lake,	0.16
Adams, Dry Brook,	0.17
Huntington, Cold Brook,	0.17
Leominster, Haynes Reservoir,	0.17
South Hadley, Buttery Brook Reservoir,	0.17
Cambridge, Fresh Pond,	0.18

TABLE NO. 17. — *Color of Surface Waters* — Concluded.

[Parts per 100,000.]

Lee, Codding Brook,	0.18
Easthampton, Bassett Brook,	0.19
Hingham, Accord Pond,	0.19
Leominster, Morse Reservoir,	0.19
Metropolitan Water District, Wachusett Reservoir,	0.20
Hinsdale, storage reservoir,	0.20
Milford, Charles River, filtered,	0.20
Winchester, Middle Reservoir,	0.20
Northampton, Middle Reservoir,	0.21
Metropolitan Water District, Framingam Reservoir No. 3,	0.22
Metropolitan Water District, Lake Cochituate,	0.22
New Bedford, tap in City Hall,	0.22
Metropolitan Water District, tap in Quincy,	0.23
Worcester, Leicester Reservoir,	0.23
Metropolitan Water District, Sudbury Reservoir,	0.24
Metropolitan Water District, tap in State House,	0.24
Ipswich, Dow's Brook Reservoir,	0.24
Dalton, Egypt Brook Reservoir,	0.25
Lynn, Glen Lewis Reservoir,	0.25
New Bedford, Little Quittacas Pond,	0.25
Taunton, Assawompsett Pond,	0.26
Metropolitan Water District, Chestnut Hill Reservoir,	0.27
Northbridge, Cook Allen Reservoir,	0.27
Palmer, Lower Reservoir,	0.27
Rockport, Cape Pond,	0.27
Springfield, Ludlow Reservoir,	0.27
Worcester, Kent Reservoir,	0.29
Pittsfield, Ashley Lake,	0.31
Holyoke, Manhan River,	0.32
Metropolitan Water District, Nashua River,	0.34
Gloucester, Dike's Brook Reservoir,	0.34
Lawrence, Merrimack River, filtered,	0.34
Lynn, Birch Reservoir,	0.34
Lee, Upper Reservoir on Codding Brook,	0.35
Southbridge, Hatchet Brook Reservoir,	0.35
Lynn, Breed's Reservoir,	0.36
Lynn, tap,	0.36
Gloucester, Wallace Reservoir,	0.37
Springfield, Ludlow Canal,	0.37
Athol, Buckman Brook Reservoir,	0.38
Lynn, Hawkes Reservoir,	0.38
Amherst, Amethyst Brook Reservoir,	0.39
Lynn, Walden Reservoir,	0.39
Cambridge, Stony Brook Reservoir,	0.40
Randolph, Great Pond,	0.40
New Bedford, Great Quittacas Pond,	0.43
Gloucester, Haskell Brook Reservoir,	0.45
Marlborough, Millham Brook Reservoir,	0.46
Westfield, Montgomery Reservoir,	0.48
Metropolitan Water District, Hopkinton Reservoir,	0.51
Haverhill, Millvale Reservoir,	0.52
North Brookfield, North Pond,	0.52
North Brookfield, Doane Pond,	0.53
Danvers, Middleton Pond,	0.54
Metropolitan Water District, Ashland Reservoir,	0.55
Brockton, Salisbury Brook Reservoir,	0.55
Chicopee, Cooley Brook,	0.59
Whitman, Hobart's Pond,	0.60
Northborough, Lower Reservoir,	0.61
Athol, Phillipston Reservoir,	0.62
Metropolitan Water District, Framingham Reservoir No. 2,	0.69
Weymouth, Great Pond,	0.69
Wayland, Snake Brook Reservoir,	0.80
Lynn, Saugus River,	0.86
Salem, Longham Reservoir,	0.94
New Bedford, old storage reservoir,	1.00

Table No. 18. — *Color of the Water of Streams.*

[Parts per 100,000.]

Cheshire, Thunder Brook,	.01
Cheshire, Kitchen Brook,	.01
Great Barrington, Green River,	.01
Adams, Bassett Brook,	.02
Chicopee, Morton Brook,	.02
Williamstown, Paul Brook,	.02
Deerfield, Roaring Brook,	.03
Pittsfield, Mill Brook,	.03
Pittsfield, Hathaway Brook,	.05
Longmeadow, Cooley Brook,	.06
Chester, Austin Brook,	.07
Pittsfield, Sacket Brook,	.07
Westfield, Tillotson Brook,	.08
Northampton, West Brook,	.13
Pittsfield, Ashley Brook,	.14
North Adams, Broad Brook,	.16
Adams, Dry Brook,	.17
Huntington, Cold Brook,	.17
Lee, Codding Brook,	.18
Easthampton, Bassett Brook,	.19
Milford, Charles River, filtered,	.20
Holyoke, Manhan River,	.32
Metropolitan Water District, Nashua River,	.34
Lawrence, Merrimack River, filtered,	.34
Springfield, Ludlow Canal,	.37
Chicopee, Cooley Brook,	.59
Lynn, Saugus River,	.86

Table No. 19. — *Color of the Water of Lakes and Ponds.*

[Parts per 100,000.]

Falmouth, Long Pond,	.00
Plymouth, Little South Pond,	.01
Concord, Sandy Pond,	.02
Montague, Lake Pleasant,	.02
Wareham, Jonathan's Pond,	.02
Peabody, Spring Pond,	.03
Spencer, Shaw Pond,	.03
Haverhill, Pentucket Lake,	.04
Maynard, White Pond,	.04
Springfield, Chapin Pond,	.04
Gardner, Crystal Lake,	.05
Rutland, Muschopauge Lake,	.05
Taunton, Elder's Pond,	.05
Fitchburg, Meetinghouse Pond,	.06
Nantucket, Wannacomet Pond,	.07
Springfield, Five Mile Pond,	.07
Hudson, Gates Pond,	.08
Marlborough, Lake Williams,	.08
Brockton, Silver Lake,	.09
Haverhill, Kenoza Lake,	.09
Stockbridge, Lake Averic,	.09
Haverhill, Johnson's Pond,	.10
Norwood, Buckmaster Pond,	.10
Abington, Big Sandy Pond,	.11
North Andover, Great Pond,	.12
Salem, Wenham Lake,	.12
Andover, Haggett's Pond,	.13
Natick, Dug Pond,	.13
Fall River, North Watuppa Lake,	.15
Peabody, Brown's Pond,	.15
Haverhill, Crystal Lake,	.16
Wakefield, Crystal Lake,	.16
Cambridge, Fresh Pond,	.18
Hingham, Accord Pond,	.19
Metropolitan Water District, Lake Cochituate,	.22
New Bedford, Little Quittacas Pond,	.25
Taunton, Assawompsett Pond,	.26
Rockport, Cape Pond,	.27
Pittsfield, Ashley Lake,	.31
Randolph, Great Pond,	.40
New Bedford, Great Quittacas Pond,	.43
Danvers, Middleton Pond,	.54
Weymouth, Great Pond,	.69

TABLE No. 20. — *Color of the Water of Storage Reservoirs.*

[Parts per 100,000.]

Greenfield, Glen Brook Reservoir,	0.02
North Adams, Notch Brook Reservoir,	0.03
South Hadley, Leaping Well Reservoir,	0.03
Northampton, Mountain Street Reservoir,	0.04
Lenox, reservoir,	0.05
Barre, reservoir,	0.07
Williamstown, Flora Glen Reservoir,	0.07
Worcester, Lower Holden Reservoir,	0.07
Holyoke, Whiting Street Reservoir,	0.08
Winchester, North Reservoir,	0.08
Holyoke, Wright and Ashley Pond,	0.09
Winchester, South Reservoir,	0.09
Hatfield, reservoir,	0.11
Leominster, Fall Brook Reservoir,	0.11
Great Barrington, East Mountain Reservoir,	0.12
Cambridge, Lower Hobbs Brook Reservoir,	0.13
West Springfield, Darby Brook Reservoir,	0.14
Worcester, Upper Holden Reservoir,	0.14
Fitchburg, Scott Reservoir,	0.16
Northfield, reservoir,	0.16
Leominster, Haynes Reservoir,	0.17
South Hadley, Buttery Brook Reservoir,	0.17
Leominster, Morse Reservoir,	0.19
Metropolitan Water District, Wachusett Reservoir,	0.20
Hinsdale, storage reservoir,	0.20
Winchester, Middle Reservoir,	0.20
Northampton, Middle Reservoir,	0.21
Metropolitan Water District, Framingham Reservoir No. 3,	0.22
Worcester, Leicester Reservoir,	0.23
Metropolitan Water District, Sudbury Reservoir,	0.24
Ipswich, Dow's Brook Reservoir,	0.24
Dalton, Egypt Brook Reservoir,	0.25
Lynn, Glen Lewis Reservoir,	0.25
Northbridge, Cook Allen Reservoir,	0.27
Palmer, Lower Reservoir,	0.27
Springfield, Ludlow Reservoir,	0.27
Worcester, Kent Reservoir,	0.29
Gloucester, Dike's Brook Reservoir,	0.34
Lynn, Birch Reservoir,	0.34
Lee, Upper Reservoir on Codding Brook,	0.35
Southbridge, Hatchet Brook Reservoir,	0.35
Lynn, Breed's Reservoir,	0.36
Gloucester, Wallace Reservoir,	0.37
Athol, Buckman Brook Reservoir,	0.38
Lynn, Hawkes Reservoir,	0.38
Amherst, Amethyst Brook Reservoir,	0.39
Lynn, Walden Reservoir,	0.39
Cambridge, Stony Brook Reservoir,	0.40
Gloucester, Haskell Brook Reservoir,	0.45
Marlborough, Millham Brook Reservoir,	0.46
Westfield, Montgomery Reservoir,	0.48
Metropolitan Water District, Hopkinton Reservoir,	0.51
Haverhill, Millvale Reservoir,	0.52
North Brookfield, North Pond,	0.52
North Brookfield, Doane Pond,	0.53
Metropolitan Water District, Ashland Reservoir,	0.55
Brockton, Salisbury Brook Reservoir,	0.55
Whitman, Hobart's Pond,	0.60
Northborough, Lower Reservoir,	0.61
Athol, Phillipston Reservoir,	0.62
Metropolitan Water District, Framingham Reservoir No. 2,	0.69
Wayland, Snake Brook Reservoir,	0.80
Salem, Longham Reservoir,	0.94
New Bedford, old storage reservoir,	1.00

Hardness of Surface Waters.

The normal waters in most parts of Massachusetts are soft. The waters which have the greatest hardness are those of the limestone regions, located chiefly in the westerly part of the State, and those derived from populous districts.

The following table gives the hardness of the various sources of water supply used in the State. It will be seen from this table that the waters having the highest hardness are all located in Berkshire County, the only waters in the eastern part of the State having a hardness in excess of 2.5 parts per 100,000 being Fresh Pond, the water supply of Cambridge, and the Saugus River, used as a source of water supply of Lynn. Fresh Pond has probably been affected somewhat by sea water, and considerably by the large population living in its neighborhood; while the hardness of the Saugus River water is caused by pollution from the very large population within its water-shed.

Table No. 21.— *Hardness of Surface Waters.*

[Parts per 100,000.]

Leominster, Morse Reservoir,	0.1	Taunton, Elder's Pond,	0.4
Leominster, Haynes Reservoir,	0.1	Abington, Big Sandy Pond,	0.5
Plymouth, Little South Pond,	0.1	Fitchburg, Meetinghouse Pond,	0.5
Wareham, Jonathan's Pond,	0.1	North Brookfield, Doane Pond,	0.5
Falmouth, Long Pond,	0.2	North Brookfield, North Pond,	0.5
Hinsdale, storage reservoir,	0.2	South Hadley, Leaping Well Reservoir,	0.5
Leominster, Fall Brook Reservoir,	0.2	Taunton, Assawompsett Pond,	0.5
Fitchburg, Scott Reservoir,	0.3	Westfield, Tillotson Brook,	0.5
Gloucester, Dike's Brook Reservoir,	0.3	Weymouth, Great Pond,	0.5
Hingham, Accord Pond,	0.3	Athol, Phillipston Reservoir,	0.6
Westfield, Montgomery Reservoir,	0.3	Brockton, Salisbury Brook Reservoir,	0.6
Worcester, Upper Holden Reservoir,	0.3	Fall River, North Watuppa Lake,	0.6
Amherst, Amethyst Brook Reservoir,	0.4	Hudson, Gates Pond,	0.6
Brockton, Silver Lake,	0.4	Maynard, White Pond,	0.6
Concord, Sandy Pond,	0.4	New Bedford, Little Quittacas Pond,	0.6
Gloucester, Wallace Reservoir,	0.4	New Bedford, Great Quittacas Pond,	0.6
Gloucester, Haskell Brook Reservoir,	0.4	Palmer, Lower Reservoir,	0.6
Lee, Upper Reservoir on Codding Brook,	0.4	Peabody, Brown's Pond,	0.6
Lynn, Glen Lewis Reservoir,	0.4	Southbridge, Hatchet Brook Reservoir,	0.6
Montague, Lake Pleasant,	0.4	Worcester, Lower Holden Reservoir,	0.6
Northbridge, Cook Allen Reservoir,	0.4	Athol, Buckman Brook Reservoir,	0.7
Rutland, Muschopauge Lake,	0.4	Chicopee, Morton Brook,	0.7
Springfield, Chapin Pond,	0.4	Lynn, Walden Reservoir,	0.7
Springfield, Five Mile Pond,	0.4	New Bedford, tap in City Hall,	0.7

TABLE NO. 21. — *Hardness of Surface Waters* — Continued.

[Parts per 100,000.]

Northfield, reservoir,	0.7
Norwood, Buckmaster Pond,	0.7
Spencer, Shaw Pond,	0.7
Springfield, Ludlow Reservoir,	0.7
Metropolitan Water District, Ashland Reservoir,	0.8
Metropolitan Water District, Hopkinton Reservoir,	0.8
Dalton, Egypt Brook Reservoir,	0.8
Lynn, Breed's Reservoir,	0.8
Worcester, Leicester Reservoir,	0.8
Metropolitan Water District, Nashua River,	0.9
Metropolitan Water District, Wachusett Reservoir,	0.9
Chicopee, Cooley Brook,	0.9
Haverhill, Crystal Lake,	0.9
New Bedford, old storage reservoir,	0.9
Northborough, Lower Reservoir,	0.9
South Hadley, Buttery Brook Reservoir,	0.9
Worcester, Kent Reservoir,	0.9
Metropolitan Water District, Framingham Reservoir No. 2,	1.0
Huntington, Cold Brook,	1.0
Randolph, Great Pond,	1.0
Springfield, Ludlow Canal,	1.0
Lynn, Birch Reservoir,	1.1
Milford, Charles River, filtered,	1.1
Winchester, Middle Reservoir,	1.1
Metropolitan Water District, Sudbury Reservoir,	1.2
Andover, Haggett's Pond,	1.2
Barre, reservoir,	1.2
Danvers, Middleton Pond,	1.2
Easthampton, Bassett Brook,	1.2
Lynn, tap,	1.2
North Andover, Great Pond,	1.2
Winchester, South Reservoir,	1.2
Metropolitan Water District, Framingham Reservoir No. 3,	1.3
Metropolitan Water District, Chestnut Hill Reservoir,	1.3
Gardner, Crystal Lake,	1.3
Marlborough, Millham Brook Reservoir,	1.3
Rockport, Cape Pond,	1.3
Wayland, Snake Brook Reservoir,	1.3
Chester, Austin Brook,	1.4
Holyoke, Manhan River,	1.4
Lynn, Hawkes Reservoir,	1.4
Metropolitan Water District, tap in State House,	1.5
Nantucket, Wannacomet Pond,	1.5
Northampton, Middle Reservoir,	1.5
Peabody, Spring Pond,	1.5
Metropolitan Water District, Spot Pond,	1.6
Metropolitan Water District, tap in Quincy,	1.6
Haverhill, Pentucket Lake,	1.6
Ipswich, Dow's Brook Reservoir,	1.6
Marlborough, Lake Williams,	1.6
Northampton, Mountain Street Reservoir,	1.6
Metropolitan Water District, tap in Revere,	1.7
Hatfield, reservoir,	1.7
Haverhill, Kenoza Lake,	1.7
Haverhill, Millvale Reservoir,	1.7
Lawrence, Merrimack River, filtered,	1.7
Lee, Codding Brook,	1.7
Northampton, West Brook,	1.7
North Adams, Broad Brook,	1.8
Salem, Longham Reservoir,	1.8
Whitman, Hobart's Pond,	1.8
Haverhill, Johnson's Pond,	1.9
Wakefield, Crystal Lake,	1.9
Metropolitan Water District, Lake Cochituate,	2.0
Winchester, North Reservoir,	2.0
Cambridge, Lower Hobbs Brook Reservoir,	2.1
Holyoke, Wright and Ashley Pond,	2.1
Natick, Dug Pond,	2.1
Cambridge, Stony Brook Reservoir,	2.2

TABLE No. 21. — *Hardness of Surface Waters* — Concluded.

[Parts per 100,000.]

Salem, Wenham Lake,	2.2	Deerfield, Roaring Brook,	3.5
Pittsfield, Ashley Lake,	2.3	Williamstown, Flora Glen Reservoir,	3.5
Holyoke, Whiting Street Reservoir,	2.4	Cheshire, Kitchen Brook,	3.6
Longmeadow, Cooley Brook,	2.4	Pittsfield, Mill Brook Reservoir,	3.6
Adams, Bassett Brook,	2.5	Stockbridge, Lake Averic,	3.7
West Springfield, Darby Brook Reservoir,	2.6	Pittsfield, Ashley Brook,	4.6
Williamstown, Paul Brook,	2.8	Adams, Dry Brook,	4.9
Great Barrington, East Mountain Reservoir,	3.0	North Adams, Notch Brook Reservoir,	5.0
Cambridge, Fresh Pond,	3.2	Pittsfield, Sacket Brook,	5.1
Lynn, Saugus River,	3.2	Lenox, reservoir,	5.3
Cheshire, Thunder Brook,	3.3	Great Barrington, Green River,	6.4
Greenfield, Glen Brook Reservoir,	3.3	Pittsfield, Hathaway Brook,	6.7

NITRATES IN SURFACE WATERS.

The determination of nitrates is of much less importance in surface waters than in ground waters. It serves, however, in a general way as an index of pollution, especially in the streams, and to a less extent in the larger ponds and reservoirs, since under the latter conditions they are quickly absorbed by growing organisms. The average quantity found in the various waters is shown by the following table: —

TABLE No. 22. — *Nitrates in Surface Waters.*

[Parts per 100,000.]

Falmouth, Long Pond,	.0006	Plymouth, Little South Pond,	.0016
Great Barrington, East Mountain Reservoir,	.0008	Taunton, Assawompsett Pond,	.0016
Barre, reservoir,	.0010	Taunton, Elder's Pond,	.0017
Gloucester, Haskell Brook Reservoir,	.0010	Concord, Sandy Pond,	.0018
New Bedford, Great Quittacas Pond,	.0010	Fall River, North Watuppa Lake,	.0018
Haverhill, Kenoza Lake,	.0011	Nantucket, Wannacomet Pond,	.0018
Peabody, Spring Pond,	.0012	Springfield, Chapin Pond,	.0018
Brockton, Silver Lake,	.0013	Springfield, Five Mile Pond,	.0018
Brockton, Salisbury Brook Reservoir,	.0014	Haverhill, Crystal Lake,	.0019
New Bedford, Little Quittacas Pond,	.0014	Haverhill, Pentucket Lake,	.0019
New Bedford, tap in City Hall,	.0014	Lynn, Glen Lewis Reservoir,	.0019
Wareham, Jonathan's Pond,	.0015	Northbridge, Cook Allen Reservoir,	.0019
Danvers, Middleton Pond,	.0016	Abington, Big Sandy Pond,	.0020
Fitchburg, Meetinghouse Pond,	.0016	Andover, Haggett's Pond,	.0020
Gloucester, Wallace Reservoir,	.0016	North Andover, Great Pond,	.0020
Hingham, Accord Pond,	.0016	Rutland, Muschopauge Lake,	.0020
		Leominster, Haynes Reservoir,	.0021

TABLE NO. 22. — *Nitrates in Surface Waters* — Continued.

[Parts per 100,000.]

Leominster, Fall Brook Reservoir,	.0021
Lynn, Walden Reservoir,	.0021
New Bedford, old storage reservoir,	.0021
Northfield, reservoir,	.0021
Haverhill, Johnson's Pond,	.0022
Holyoke, Whiting Street Reservoir,	.0024
Leominster, Morse Reservoir,	.0024
Worcester, Upper Holden Reservoir,	.0024
Palmer, Lower Reservoir,	.0025
Metropolitan Water District, Ashland Reservoir,	.0026
Fitchburg, Scott Reservoir,	.0026
Metropolitan Water District, Wachusett Reservoir,	.0027
Worcester, Lower Holden Reservoir,	.0027
Lynn, Breed's Reservoir,	.0028
Stockbridge, Lake Averic,	.0028
Winchester, North Reservoir,	.0028
Athol, Buckman Brook Reservoir,	.0029
Haverhill, Millvale Reservoir,	.0029
Holyoke, Manhan River,	.0029
Gloucester, Dike's Brook Reservoir,	.0030
Weymouth, Great Pond,	.0030
Lynn, Hawkes Reservoir,	.0031
Lee, Upper Reservoir on Codding Brook,	.0032
Westfield, Montgomery Reservoir,	.0032
Metropolitan Water District, Spot Pond,	.0033
Chicopee, Cooley Brook,	.0033
Holyoke, Wright and Ashley Pond,	.0033
Northampton, Middle Reservoir,	.0033
Norwood, Buckmaster Pond,	.0033
Peabody, Brown's Pond,	.0033
Southbridge, Hatchet Brook Reservoir,	.0033
Maynard, White Pond,	.0034
North Adams, Notch Brook Reservoir,	.0034
Williamstown, Flora Glen Reservoir,	.0034
Cambridge, Lower Hobbs Brook Reservoir,	.0035
Amherst, Amethyst Brook Reservoir,	.0037
Northampton, West Brook,	.0037
Westfield, Tillotson Brook,	.0037
Winchester, South Reservoir,	.0037
Marlborough, Lake Williams,	.0038
Metropolitan Water District, Hopkinton Reservoir,	.0039
Huntington, Cold Brook,	.0040
Montague, Lake Pleasant,	.0040
Hinsdale, storage reservoir,	.0041
Pittsfield, Ashley Lake,	.0041
Athol, Phillipston Reservoir,	.0042
Randolph, Great Pond,	.0042
Ipswich, Dow's Brook Reservoir,	.0044
Lynn, Birch Reservoir,	.0044
South Hadley, Leaping Well Reservoir,	.0045
Hudson, Gates Pond,	.0046
Easthampton, Bassett Brook,	.0048
Lenox, reservoir,	.0048
Springfield, Ludlow Canal,	.0048
North Brookfield, Doane Pond,	.0049
Winchester, Middle Reservoir,	.0049
Lynn, Saugus River,	.0051
Northampton, Mountain Street Reservoir,	.0051
Northborough, Lower Reservoir,	.0051
Spencer, Shaw Pond,	.0051
Chicopee, Morton Brook,	.0052
Lynn, tap,	.0053
Springfield, Ludlow Reservoir,	.0055
Metropolitan Water District, tap in Revere,	.0057
Lee, Codding Brook,	.0057
West Springfield, Darby Brook Reservoir,	.0057
Metropolitan Water District, Framingham Reservoir No. 2,	.0058
North Brookfield, North Pond,	.0058
Salem, Wenham Lake,	.0062
Wayland, Snake Brook Reservoir,	.0062
Worcester, Leicester Reservoir,	.0064

TABLE No. 22.— *Nitrates in Surface Waters*— Concluded.

[Parts per 100,000.]

Metropolitan Water District, Nashua River,	.0066
Cheshire, Kitchen Brook,	.0069
Chester, Austin Brook,	.0070
Whitman, Hobart's Pond,	.0070
Worcester, Kent Reservoir,	.0070
Marlborough, Millham Brook Reservoir,	.0071
Pittsfield, Mill Brook,	.0071
Gardner, Crystal Lake,	.0073
Wakefield, Crystal Lake,	.0073
Metropolitan Water District, Lake Cochituate,	.0076
Rockport, Cape Pond,	.0077
Deerfield, Roaring Brook,	.0080
Pittsfield, Ashley Brook,	.0080
Adams, Dry Brook,	.0084
Cheshire, Thunder Brook,	.0085
Metropolitan Water District, Sudbury Reservoir,	.0090
Metropolitan Water District, Chestnut Hill Reservoir,	.0105
Metropolitan Water District, tap in State House,	.0119
Hatfield, reservoir,	.0119
Metropolitan Water District, Framingham Reservoir No. 3,	.0120
Greenfield, Glen Brook Reservoir,	.0121
Natick, Dug Pond,	.0137
Cambridge, Stony Brook Reservoir,	.0138
Pittsfield, Hathaway Brook,	.0140
Pittsfield, Sacket Brook,	.0141
Salem, Longham Reservoir,	.0143
Williamstown, Paul Brook,	.0149
Metropolitan Water District, tap in Quincy,	.0155
Adams, Bassett Brook,	.0159
Dalton, Egypt Brook Reservoir,	.0162
Milford, Charles River, filtered,	.0165
North Adams, Broad Brook,	.0179
Cambridge, Fresh Pond,	.0245
Lawrence, Merrimack River, filtered,	.0255
South Hadley, Buttery Brook Reservoir,	.0262
Longmeadow, Cooley Brook,	.0265
Great Barrington, Green River,	.0270

RESIDUE ON EVAPORATION IN SURFACE WATERS.

The amount of dissolved mineral matter found in the waters of the State is, in general, highest in Berkshire, where many of the waters dissolve limestone from the rocks and soil over which they flow, and it is also large in the ponds and reservoirs nearest the sea. Except in these cases a high total residue is usually an indication of sewage pollution.

The highest residue found in any water is in Cape Pond in Rockport, due probably to pollution by wastes from a glue factory. Wannacomet Pond in Nantucket, though having a high total residue, is free from pollution, and the large quantity of mineral matter is doubtless to be explained by the nearness of the pond to the ocean. The high total residue in the water of the Saugus River is due to pollution from the large population on its water-shed. The large quantity of mineral matter found in the waters of Great Barrington, Pittsfield, Lenox, Adams, North Adams and other towns in the western part of the State is due to the contact of the water with limestone.

The residue on evaporation in the various surface-water supplies of the State is shown by the following table: —

TABLE NO. 23. — *Residue on Evaporation in Surface Waters.*

[Parts per 100,000.]

Hinsdale, storage reservoir,	2.06
Worcester, Upper Holden Reservoir,	2.16
Leominster, Fall Brook Reservoir,	2.17
Rutland, Muschopauge Lake,	2.17
Leominster, Morse Reservoir,	2.24
Springfield, Chapin Pond,	2.25
Leominster, Haynes Reservoir,	2.26
Worcester, Lower Holden Reservoir,	2.26
Spencer, Shaw Pond,	2.31
Wareham, Jonathan's Pond,	2.33
Fitchburg, Meetinghouse Pond,	2.36
Concord, Sandy Pond,	2.37
Montague, Lake Pleasant,	2.46
Fitchburg, Scott Reservoir,	2.47
Plymouth, Little South Pond,	2.48
Springfield, Five Mile Pond,	2.50
Hudson, Gates Pond,	2.53
South Hadley, Leaping Well Reservoir,	2.59
Dalton, Egypt Brook Reservoir,	2.60
Westfield, Tillotson Brook,	2.61
Westfield, Montgomery Reservoir,	2.65
Maynard, White Pond,	2.67
Taunton, Elder's Pond,	2.75
Lee, Upper Reservoir on Codding Brook,	2.79
Metropolitan Water District, Wachusett Reservoir,	2.86
Springfield, Ludlow Reservoir,	2.88
Falmouth, Long Pond,	2.90
Hingham, Accord Pond,	2.90
Northfield, reservoir,	2.94
Brockton, Silver Lake,	2.95
Chester, Austin Brook,	3.00
Worcester, Leicester Reservoir,	3.01
Haverhill, Crystal Lake,	3.02
Norwood, Buckmaster Pond,	3.04
Lynn, Glen Lewis Reservoir,	3.08
Peabody, Brown's Pond,	3.10
Northbridge, Cook Allen Reservoir,	3.13
Southbridge, Hatchet Brook Reservoir,	3.15
Winchester, South Reservoir,	3.15
Andover, Haggett's Pond,	3.16
Taunton, Assawompsett Pond,	3.16
Huntington, Cold Brook,	3.17
North Brookfield, Doane Pond,	3.21
Abington, Big Sandy Pond,	3.22
Worcester, Kent Reservoir,	3.24
New Bedford, tap in City Hall,	3.32
Athol, Buckman Brook Reservoir,	3.34
New Bedford, Little Quittacas Pond,	3.34
Fall River, North Watuppa Lake,	3.35
North Brookfield, North Pond,	3.35
Amherst, Amethyst Brook Reservoir,	3.36
Palmer, Lower Reservoir,	3.36
North Andover, Great Pond,	3.39
New Bedford, Great Quittacas Pond,	3.42
Winchester, Middle Reservoir,	3.42
Athol, Phillipston Reservoir,	3.43
Chicopee, Morton Brook,	3.46
Springfield, Ludlow Canal,	3.46
Lynn, Walden Reservoir,	3.50
Lynn, Breed's Reservoir,	3.51
Metropolitan Water District, Ashland Reservoir,	3.55
Easthampton, Bassett Brook,	3.55
Lee, Codding Brook,	3.56
Haverhill, Pentucket Lake,	3.61
Metropolitan Water District, Nashua River,	3.63
North Adams, Broad Brook,	3.63
Barre, reservoir,	3.65
Holyoke, Manhan River,	3.67
Northampton, Mountain Street Reservoir,	3.67
Metropolitan Water District, Sudbury Reservoir,	3.68

TABLE NO. 23. — *Residue on Evaporation in Surface Waters* — Concluded.

[Parts per 100,000.]

Metropolitan Water District, Hopkinton Reservoir,	3.70
Brockton, Salisbury Brook Reservoir,	3.70
Haverhill, Kenoza Lake,	3.71
Adams, Bassett Brook,	3.72
Northborough, Lower Reservoir,	3.74
Gardner, Crystal Lake,	3.76
Gloucester, Dike's Brook Reservoir,	3.78
Northampton, West Brook,	3.78
South Hadley, Buttery Brook Reservoir,	3.78
Danvers, Middleton Pond,	3.81
Metropolitan Water District, Framingham Reservoir No. 3,	3.85
Metropolitan Water District, Chestnut Hill Reservoir,	3.87
Hatfield, reservoir,	3.88
Northampton, Middle Reservoir,	3.88
Weymouth, Great Pond,	3.89
Milford, Charles River, filtered,	3.93
Metropolitan Water District, Spot Pond,	3.94
Metropolitan Water District, tap in Revere,	3.95
Marlborough, Millham Brook Reservoir,	3.95
Randolph, Great Pond,	3.96
Lynn, Birch Reservoir,	3.98
Peabody, Spring Pond,	4.00
Metropolitan Water District, tap in State House,	4.01
Haverhill, Johnson's Pond,	4.03
Gloucester, Haskell Brook Reservoir,	4.06
Metropolitan Water District, tap in Quincy,	4.07
Lynn, tap,	4.10
Chicopee, Cooley Brook,	4.12
Marlborough, Lake Williams,	4.12
Williamstown, Paul Brook,	4.15
Gloucester, Wallace Reservoir,	4.17
Metropolitan Water District, Framingham Reservoir No. 2,	4.19
Holyoke, Wright and Ashley Pond,	4.20
Holyoke, Whiting Street Reservoir,	4.24
Lynn, Hawkes Reservoir,	4.37
Cheshire, Thunder Brook,	4.42
Ipswich, Dow's Brook Reservoir,	4.45
Wakefield, Crystal Lake,	4.49
Longmeadow, Cooley Brook,	4.50
Winchester, North Reservoir,	4.51
Wayland, Snake Brook Reservoir,	4.53
Great Barrington, East Mountain Reservoir,	4.56
Lawrence, Merrimack River, filtered,	4.56
Pittsfield, Ashley Lake,	4.57
Haverhill, Millvale Reservoir,	4.77
New Bedford, old storage reservoir,	4.77
Metropolitan Water District, Lake Cochituate,	4.85
Cambridge, Lower Hobbs Brook Reservoir,	4.89
Natick, Dug Pond,	4.95
Cheshire, Kitchen Brook,	5.01
Pittsfield, Mill Brook,	5.08
Greenfield, Glen Brook Reservoir,	5.10
West Springfield, Darby Brook Reservoir,	5.13
Cambridge, Stony Brook Reservoir,	5.42
Williamstown, Flora Glen Reservoir,	5.43
Salem, Wenham Lake,	5.47
Stockbridge, Lake Averic,	5.70
Deerfield, Roaring Brook,	5.82
Pittsfield, Ashley Brook,	6.13
Whitman, Hobart's Pond,	6.22
Salem, Longham Reservoir,	6.26
Pittsfield, Sacket Brook,	6.43
North Adams, Notch Brook Reservoir,	6.75
Nantucket, Wannacomet Pond,	6.78
Cambridge, Fresh Pond,	6.88
Adams, Dry Brook,	7.22
Lynn, Saugus River,	7.49
Lenox, reservoir,	8.05
Pittsfield, Hathaway Brook,	8.28
Great Barrington, Green River,	8.39
Rockport, Cape Pond,	9.12

Ground-water Supplies.

The ground-water supplies in the State are fewer in number than the surface-water sources, and supply in the aggregate a much smaller number of people. Most of the older water works systems which serve the larger communities are supplied from surface sources, while the newer supplies are in most cases obtained from the ground. The most common method of obtaining ground water is by means of tubular wells, ranging in depth from 25 feet to 50 feet or more, and more ground-water supplies are obtained in this way than by any other method. Next in number are the supplies obtained from large circular wells, generally from 20 feet to 40 feet deep; then come the filter-galleries, so called, which are usually elongated wells 10 feet to 20 feet in depth, located along the shore of a pond or near a stream. The filter-galleries are usually rectangular in section, though sometimes of irregular shape, and are in some cases several hundred feet in length. Both the large wells and the filter-galleries are in many cases supplemented by tubular wells sunk in their bottoms or in their immediate neighborhood. A few ground-water supplies are obtained directly from natural springs.

Normal ground waters are colorless, contain very little organic matter, and are ordinarily affected by mineral matter in no greater degree than the surface waters of the same region. On account of their attractive appearance and freedom from color, taste or odor, their low temperature in summer, and the greater safety in their use as compared with surface waters, especially in populous regions, ground waters are much the more desirable sources of water supply if they can be obtained. Most of the larger supplies of ground water, such as those at Lowell, Brookline, Newton, Waltham, Woburn, etc., are obtained from the neighborhood of large streams or ponds, and while the water is derived in part from the rain which falls upon and sinks into the ground in the neighborhood of the collecting works, it is derived largely, and in many cases chiefly, from the water which percolates through the ground from the neighboring pond or stream. The surface waters which percolate from ponds or streams through the ground to the various filter-galleries or wells are in most cases well purified in their passage through the soil, and become ground waters, differing in no important respect from the waters of wells or springs supplied wholly by the rainfall upon porous soil about them; but some of the ground waters derived from such sources deteriorate in quality after a time on account of a gradual reduction in the efficiency of the purification effected in their passage through the soil. This is especially apt to be the case when the distance from the surface source to the well is quite short. The marked characteristics of such deterioration are an increased quantity of iron and ammonia, and the presence of turbidity, sediment and color,

and such deterioration has in some cases become so great as to cause the abandonment of the source of supply.

The averages of the analyses of all the ground-water sources made during the past five years have been calculated in the same way as those of the surface-water sources, and the results are presented in the following table, in which the analyses of the various sources are given alphabetically by towns.

The ground-water sources have been examined generally once in two or three months, but in a few cases as often as once a month.

Some of the sources have been in use for a period of less than five years, and these are mentioned in the notes following the table.

TABLE NO. 24.—*Averages of Chemical Analyses from 1900 to 1904 inclusive.*

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.			
Adams,	Tubular wells,*	.00	13.60	.0001	.0005	0.09	.0440	.0000	.01	9.7	.0035
Amesbury,	Main Street wells,	.09	10.33	.0018	.0015	0.78	.0816	.0002	.03	4.4	.0570
	Market Street wells,	.01	25.09	.0036	.0028	1.31	.0047	.0002	.04	11.7	.0094
Attleborough,	Well,	.01	4.02	.0006	.0031	0.34	.0092	.0000	.05	1.8	.0070
Avon,	Well,	.00	3.70	.0005	.0011	0.35	.0419	.0000	.01	1.1	.0045
Ayer,	Well,	.00	5.51	.0005	.0018	0.44	.0384	.0000	.02	2.2	.0088
Billerica,	Tubular wells,	.06	6.50	.0009	.0026	0.27	.0080	.0000	.08	2.3	.0327
Braintree,	Filter-gallery,	.06	5.09	.0017	.0078	0.81	.0406	.0000	.17	1.7	.0083
Bridgewater,	Wells,	.13	6.91	.0007	.0031	0.45	.0163	.0000	.06	2.3	.0849
Brookline,	Tubular wells and filter-gallery.	.04	9.02	.0036	.0041	0.58	.0362	.0002	.10	4.6	.0123
Canton,	Springdale well,	.00	3.61	.0002	.0010	0.32	.0042	.0000	.02	1.0	.0079
	Well near Henry's Spring,	.04	3.94	.0002	.0023	0.37	.0190	.0000	.03	1.2	.0063
Cohasset,	Tubular wells No. 1,	.04	13.24	.0006	.0020	1.66	.0344	.0000	.03	6.0	.0215
	Tubular wells No. 2,	.01	13.54	.0003	.0017	1.44	.0807	.0000	.02	5.6	.0079
	Filter-gallery,*	.11	11.14	.0591	.0093	1.13	.0041	.0001	.28	5.1	.0134
Cottage City,	Springs,	.02	3.89	.0003	.0013	0.95	.0102	.0000	.02	0.6	.0133
Dedham,	Large well,	.00	8.97	.0010	.0038	0.76	.1619	.0000	.04	3.8	.0060
	Tubular wells,	.00	13.97	.0012	.0016	1.30	.4011	.0002	.02	5.4	.0102
Dracut,	Tubular wells,	.00	4.60	.0005	.0015	0.22	.0224	.0000	.02	1.7	.0061
Easton,	Well,	.00	4.43	.0003	.0015	0.49	.0524	.0000	.01	1.5	.0052
Fairhaven,	Tubular wells,	.36	6.36	.0008	.0095	0.91	.0299	.0001	.50	1.9	.0356
Foxborough,	Tubular wells,	.00	3.58	.0002	.0006	0.34	.0419	.0000	.01	0.7	.0072
Framingham,	Filter-gallery,	.02	8.17	.0033	.0050	0.85	.0337	.0003	.06	3.8	.0133
Franklin,	Wells,*	.38	6.43	.0031	.0156	0.63	.1027	.0002	.48	2.1	.0169

* See notes.

TABLE No. 24. — *Averages of Chemical Analyses from 1900 to 1904 inclusive* — Continued.

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Grafton,	Filter-gallery,	.04	10.27	.0003	.0029	1.24	.2273	.0000	.06	3.7	.0068
Groton,	Well,	.00	4.31	.0003	.0009	0.16	.0079	.0000	.01	1.9	.0059
Hingham,	Wells,*	.02	5.27	.0009	.0023	0.71	.0115	.0000	.04	2.0	.0170
Holliston,	Well,*	.27	3.80	.0008	.0111	0.28	.0044	.0000	.32	1.2	.0266
Hopkinton,	Tubular wells,	.00	11.52	.0003	.0019	1.09	.3805	.0000	.02	4.6	.0094
Hyde Park,	Tubular wells near the Neponset River.	.05	10.37	.0107	.0042	1.23	.1011	.0002	.09	4.4	.0341
	Tubular wells near Mother Brook.	.05	8.18	.0007	.0049	0.90	.1928	.0000	.12	3.1	.0069
Kingston,	Tubular wells,	.00	4.60	.0005	.0015	0.77	.0217	.0000	.01	0.9	.0074
Leicester,	Wells,	.09	6.11	.0028	.0050	0.21	.0797	.0000	.15	2.4	.0164
Lowell,	Cook wells (tubular),*	.06	3.86	.0032	.0048	0.50	.0413	.0000	.10	3.6	.0297
	Boulevard wells (tubular),	.05	4.16	.0049	.0034	0.24	.0163	.0001	.08	1.6	.0360
Manchester,	Large well,	.00	11.15	.0002	.0007	1.83	.1447	.0000	.01	3.7	.0073
	Tubular wells,	.00	9.73	.0008	.0015	1.27	.1900	.0000	.02	2.5	.0045
Mansfield,	Well,	.00	2.72	.0002	.0005	0.25	.0021	.0000	.01	0.5	.0039
Marblehead,	Well No. 1,	.08	16.99	.0140	.0026	2.27	.0213	.0002	.06	7.0	.1895
	Well No. 2,	.10	17.26	.0260	.0034	1.66	.0051	.0001	.09	6.8	.3868
Marshfield,	Well,	.00	11.88	.0004	.0010	3.44	.0748	.0000	.03	2.3	.0078
Medfield,	Spring,	.00	3.85	.0006	.0034	0.23	.0019	.0000	.07	1.0	.0046
Methuen,	Tubular wells,	.09	7.63	.0005	.0049	0.33	.0187	.0000	.10	3.4	.0210
Middleborough,	Well,	.18	6.17	.0022	.0047	0.65	.0565	.0000	.13	2.3	.0822
Millbury,	Well,	.01	6.05	.0003	.0019	0.24	.0229	.0000	.03	2.7	.0052
Millis,	Spring,	.00	7.22	.0003	.0023	0.59	.1774	.0000	.02	2.8	.0055
Monson,	Well,	.00	3.23	.0003	.0008	0.12	.0099	.0000	.01	1.0	.0058
Nantucket,	Wells,	.04	7.00	.0058	.0062	2.12	.0128	.0000	.07	1.6	.0235
Natick,	Well,*	.00	8.05	.0094	.0013	0.49	.0297	.0000	.02	4.3	.0051
Needham,	Well No. 1,	.00	5.62	.0003	.0014	0.60	.1466	.0000	.01	2.0	.0041
	Well No. 2,	.00	6.24	.0004	.0017	0.62	.1601	.0000	.01	2.3	.0047
	Hicks Spring,*	.00	4.63	.0003	.0011	0.48	.0857	.0000	.00	1.5	.0058
Newburyport,	Wells,	.08	6.06	.0004	.0036	0.47	.0231	.0000	.07	2.4	.0367
Newton,	Tubular wells and filter-gallery.	.03	6.02	.0006	.0034	0.45	.0378	.0000	.08	2.6	.0067
No. Attleborough,	Well,	.00	6.36	.0003	.0016	0.63	.0512	.0000	.03	2.9	.0089
Provincetown,	Well,	.91	10.78	.0148	.0181	2.55	.0051	.0001	.78	2.8	.4647
Reading,	Filter-gallery,*	.63	8.33	.0101	.0111	0.46	.0043	.0000	.53	2.9	.1972

* See notes.

TABLE No. 24. — *Averages of Chemical Analyses from 1900 to 1904 inclusive* — Concluded.

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.			
Reading,	Filtered water,	.20	15.26	.0066	.0081	0.47	.0042	.0009	.32	8.8	.0121
Scituate,	Wells,	.01	15.45	.0005	.0010	3.60	.1728	.0000	.02	4.5	.0088
Sharon,	Well,	.00	9.26	.0002	.0010	1.14	.2576	.0000	.01	3.5	.0057
Sheffield,	Spring,	.00	3.46	.0004	.0012	0.07	.0064	.0000	.01	1.9	.0076
Shirley,	Well,*	.01	2.45	.0002	.0008	0.14	.0022	.0000	.01	0.7	.0108
Tisbury,	Spring,	.00	4.25	.0002	.0009	1.02	.0053	.0000	.02	0.5	.0111
Uxbridge,	Spring,*	.00	2.44	.0002	.0022	0.15	.0055	.0000	.04	0.4	-
Walpole,	Tubular wells,	.00	3.92	.0001	.0006	0.33	.0160	.0000	.01	1.1	.0077
Waltham,	Well,	.06	7.14	.0031	.0041	0.58	.0269	.0000	.09	3.4	.0236
Ware,	Well,	.00	8.19	.0001	.0009	0.66	.3015	.0000	.01	2.9	.0047
Webster,	Well,	.00	3.75	.0004	.0011	0.24	.0224	.0000	.02	1.4	.0079
Wellesley,	Tubular wells,	.01	7.63	.0019	.0012	0.64	.1433	.0016	.02	3.3	.0079
	Well at Williams Spring,	.00	9.67	.0007	.0024	0.83	.3587	.0004	.04	3.5	.0059
	Filter-gallery,	.00	7.00	.0006	.0023	0.48	.0952	.0001	.04	2.8	.0038
Westborough,	Filter basin,*	.02	2.82	.0007	.0088	0.20	.0018	.0000	.18	1.1	-
Weston,	Well,	.09	6.83	.0004	.0053	0.45	.0452	.0000	.15	3.0	.0076
West Springfield,	Well,	.00	7.12	.0003	.0014	0.49	.2232	.0000	.01	2.5	.0064
Williamstown,	Cold Spring,	.01	13.12	.0004	.0017	0.06	.0374	.0000	.07	10.7	.0073
	Sherman Spring,	.02	9.52	.0003	.0045	0.06	.0143	.0000	.03	6.4	.0070
Winchendon,	Well,	.02	3.05	.0015	.0017	0.11	.0045	.0000	.03	0.9	.0178
Woburn,	Filter-gallery,	.00	9.68	.0062	.0031	1.17	.0192	.0000	.06	4.8	.0046

* See notes.

NOTES.

Adams, Tubular wells. — Completed in 1902. The water is used only in the drier portions of the year, and is pumped into Bassett Brook and thence supplied to the town.

Cohasset, Filter-gallery. — Situated on the shore of Lily Pond. It is used as an auxiliary source of supply in the drier portions of the year.

Franklin. — Water from Beaver Pond is mingled with the well water before it is supplied to the town.

Hingham, Wells. — Completed in the latter part of the year 1903

Holliston, Well. — Probably receives water directly from the adjacent pond.

Lowell, Cook wells. — These wells are not used, the water containing an excessive quantity of carbonic acid which causes it to take up lead in large quantities from the lead service pipes through which water is supplied.

Natick, Well. — Was completed and has been used for the supply of the town since 1903.

Needham, Hicks Spring. — Works for taking water from this source were built in 1904.

Reading, Filter-gallery. — The water from the filter-gallery contains an excessive quantity of iron and is treated with lime and alum and subsequently filtered through a mechanical filter. The filtered water represents the water after treatment and filtration.

Shirley, Well. — Water from this source was first used in 1903.

Uxbridge, Spring. — The analyses cover a period of one year.

Westborough, Filter basin. — The water supply of Westborough is taken from a large open basin fed by water which filters through the ground from Sandra Pond and by ground water from adjacent territory.

The most important consideration in comparing the quality of various ground waters is their relative freedom from sewage pollution. In the case of surface waters it is usually a simple matter to determine with reasonable accuracy the population within the water-shed of a source of supply which may affect the quality of its water, but in the case of a ground-water supply the area from which water percolates to the source is often indefinite and rarely determinable with accuracy, and some further means of determining the degree to which it is affected by population in the region about it is usually necessary.

Ground waters drawn from populous regions show very clearly upon chemical analysis the effect of the pollution of the water by sewage or other wastes of human life. Chlorine, though a normal constituent of the waters of all parts of the State, is a characteristic ingredient of sewage, and the normal quantity having been determined, the excess due to sewage or the wastes of human life and industry can be ascertained. The normal chlorine of the waters of the State is greatest near the sea, and decreases as the distance from the sea increases. It changes very rapidly within short distances near the seashore, and in consequence of a lack of sufficient information in some cases the normal at such places is still uncertain, but very few of the ground waters of the State are affected by this uncertainty.

The ground waters have been classified in accordance with the determination of the excess of chlorine above the normal on the same basis as that used for the examination of spring waters in 1900, and the results are presented in the tables which follow.

The first group includes normal waters and those in which the excess of chlorine above the normal is not more than .10 of a part per 100,000. The second group includes those waters in which the excess of chlorine above the normal is between .11 and .30 of a part per 100,000. The third group includes those waters in which the excess of chlorine above the normal is more than .30 of a part per 100,000.

TABLE NO. 25. — *Ground-water Sources arranged in Groups according to the Excess of Chlorine above the Normal.*

GROUP I. — *Normal Ground Waters and Those in which the Excess of Chlorine is Less than .10 of a Part per 100,000.*

City or Town.	Source.	City or Town.	Source.
Adams,	Tubular wells.	Canton,	Well near Henry's Spring.
Attleborough,	Well.	Cohasset,	Filter-gallery.
Avon,	Well.	Cottage City,	Springs.
Billerica,	Tubular wells.	Dracut,	Tubular wells.
Bridgewater,	Wells.	Foxborough,	Tubular wells.
Canton,	Springdale well.	Groton,	Well.

TABLE NO. 25.— *Ground-water Sources arranged in Groups, etc.*— Continued.

GROUP I.—*Normal Ground Waters and Those in which the Excess of Chlorine is not More than .10 of a Part per 100,000*—Concluded.

[Parts per 100,000.]

CITY OR TOWN.	Source.	CITY OR TOWN.	Source.
Hingham,	Wells.	Nantucket,	Wells.
Holliston,	Well.	Newburyport,	Wells.
Kingston,	Tubular wells.	Provincetown,	Well.
Leicester,	Wells.	Sheffield,	Spring.
Lowell,	Boulevard wells (tubular).	Shirley,	Well.
Mansfield,	Well.	Tisbury,	Spring.
Marblehead,	Well No. 1.	Uxbridge,	Spring.
Marblehead,	Well No. 2.	Walpole,	Tubular wells.
Marshfield,	Well.	Webster,	Well.
Medfield,	Spring.	Westborough,	Filter basin.
Methuen,	Tubular wells.	Williamstown,	Cold Spring.
Millbury,	Well.	Williamstown,	Sherman Spring.
Monson,	Well.	Winchendon,	Well.

GROUP II.—*Ground Waters in which the Excess of Chlorine is between .11 and .30 of a Part per 100,000.*

Ayer,	Well.	Needham,	Hicks Spring.
Brookline,	Tubular wells and filter-gallery.	Newton,	Tubular wells and filter-gallery.
Easton,	Well.	Reading,	Filter-gallery.
Fairhaven,	Tubular wells.	Reading,	Filtered water.
Lowell,	Cook wells (tubular).	Wellesley,	Filter-gallery.
Middleborough,	Well.	Weston,	Well.
Natick,	Well.		

GROUP III.—*Ground Waters in which the Excess of Chlorine is More than .30 of a Part per 100,000.*

Amesbury,	Main Street wells.	Grafton,	Filter-gallery.
Amesbury,	Market Street wells.	Hopkinton,	Tubular wells.
Braintree,	Filter-gallery.	Hyde Park,	Tubular wells near Mother Brook.
Cohasset,	Tubular wells No. 1.	Hyde Park,	Tubular wells near the Neponset River.
Cohasset,	Tubular wells No. 2.	Manchester,	Large well.
Dedham,	Large well.	Manchester,	Tubular wells.
Dedham,	Tubular wells.	Millis,	Spring.
Framingham,	Filter-gallery.	Needham,	Well No. 1.
Franklin,	Wells.	Needham,	Well No. 2.

TABLE No. 25.— *Ground-water Sources arranged in Groups, etc.*— Concluded.

GROUP III.— *Ground Waters in which the Excess of Chlorine is More than .30 of a Part per 100,000*— Concluded.

City or Town.	Source.	City or Town.	Source.
North Attleborough, .	Well.	Wellesley, . . .	Tubular wells.
Scituate, . . .	Wells.	Wellesley, . . .	Well at Williams Spring.
Sharon, . . .	Well.	West Springfield, .	Well.
Waltham, . . .	Well.	Woburn, . . .	Filter-gallery.
Ware, ...	Well.		

NITRATES IN GROUND WATERS.

The presence of nitrates in ground waters is a measure, though a somewhat less definite and reliable one in Massachusetts than the excess of chlorine, of the extent to which these waters have been exposed to pollution by sewage before entering the wells from which the water is drawn.

Ground waters from an uninhabited water-shed in which the land has not been cultivated or polluted in any way by animal matter are practically free from nitrates. The use of lands for pasturage tends to increase slightly the quantity of nitrates present in the ground water of the region so used. Ground waters from lands under cultivation, even though free from human habitation, contain a noticeably larger quantity of nitrates than in the cases where the land has been unused or used only for pasturage. In thickly settled regions, where the ground is polluted by house drainage and other animal matter, the nitrates are nearly always very high. Hence this determination is of great value as an indication of previous pollution in ground waters, and, taken in connection with the excess of chlorine, is a very important index of the amount of previous pollution these waters have received. When ground waters are exposed to light, as in an open spring or well, or especially in an open distributing reservoir, the nitrates are absorbed rapidly by organic growths ; and though the quantity may be large in the water as it enters the spring or reservoir, it may be nearly all taken up by the growths therein. While in a general way the quantity of nitrates corresponds directly with the excess of chlorine, there are some cases in which there is considerable disagreement, the reasons for which have not been made clear by the investigations thus far made. In the case of the ground waters taken from near the sea, however, the determination of the normal chlorine is in some cases doubtful, and a considerable disagreement is unavoidable.

The quantity of nitrates present in the various ground waters is given in the following table : —

TABLE No. 26. — *Nitrates in Ground Waters.*

[Parts per 100,000.]

Westborough, filter basin,	.0018
Medfield, spring,	.0019
Mansfield, well,	.0021
Shirley, well,	.0022
Cohasset, filter-gallery,	.0041
Canton, Springdale well,	.0042
Reading, filtered water,	.0042
Reading, filter-gallery,	.0043
Holliston, well,	.0044
Winchendon, well,	.0045
Amesbury, Market Street wells,	.0047
Marblehead, Well No. 2,	.0051
Provincetown, well,	.0051
Tisbury, spring,	.0053
Uxbridge, spring,	.0055
Sheffield, spring,	.0064
Groton, well,	.0079
Billerica, tubular wells,	.0080
Attleborough, well,	.0092
Monson, well,	.0099
Cottage City, springs,	.0102
Hingham, wells,	.0115
Nantucket, wells,	.0128
Williamstown, Sherman Spring,	.0143
Walpole, tubular wells,	.0160
Bridgewater, wells,	.0163
Lowell, Boulevard wells (tubular),	.0163
Methuen, tubular wells,	.0187
Canton, well near Henry's Spring,	.0190
Woburn, filter-gallery,	.0192
Marblehead, Well No. 1,	.0213
Kingston, tubular wells,	.0217
Dracut, tubular wells,	.0224
Webster, well,	.0224
Millbury, well,	.0229
Newburyport, wells,	.0231
Waltham, well,	.0269
Natick, well,	.0297
Fairhaven, tubular wells,	.0299
Framingham, filter-gallery,	.0337
Cohasset, tubular wells No. 1,	.0344
Brookline, tubular wells and filter-gallery,	.0362
Williamstown, Cold Spring,	.0374
Newton, tubular wells and filter-gallery,	.0378
Ayer, well,	.0384
Braintree, filter-gallery,	.0406
Lowell, Cook wells (tubular),	.0413
Avon, well,	.0419
Foxborough, tubular wells,	.0419
Adams, tubular wells,	.0440
Weston, well,	.0452
North Attleborough, well,	.0512
Easton, well,	.0524
Middleborough, well,	.0565
Marshfield, well,	.0746
Leicester, wells,	.0797
Cohasset, tubular wells No. 2,	.0807
Amesbury, Main Street wells,	.0816
Needham, Hicks Spring,	.0857
Wellesley, filter-gallery,	.0952
Hyde Park, tubular wells near the Neponset River,	.1011
Franklin, wells,	.1027
Wellesley, tubular wells,	.1433
Manchester, large well,	.1447
Needham, Well No. 1,	.1466
Needham, Well No. 2,	.1601
Dedham, large well,	.1619
Scituate, wells,	.1728
Millis, spring,	.1774
Manchester, tubular wells,	.1900
Hyde Park, tubular wells near Mother Brook,	.1928
West Springfield, well,	.2232
Grafton, filter-gallery,	.2273
Sharon, well,	.2576
Ware, well,	.3015
Wellesley, well at Williams Spring,	.3587
Hopkinton, tubular wells,	.3805
Dedham, tubular wells,	.4011

Ammonia in Ground Waters.

Nearly all ground waters, even those of the best springs and wells in unpopulated regions, contain very small quantities of free and albuminoid ammonia, though at times these substances are wholly absent. The determinations of chlorine and nitrates already given are the important means of showing by chemical analysis the comparative degree to which ground waters are affected by pollution; the determinations of the free and albuminoid ammonias in ground waters are indices of the extent to which a polluted water has been purified and freed from organic matter in its passage through the ground. Imperfectly purified waters, or waters which enter wells or springs while still undergoing the process of purification, usually contain considerable quantities of ammonia both free and albuminoid, and the quantity of free ammonia especially is sometimes very large. The ammonia in a ground water may be derived from sewage or from decaying vegetable or organic matter unaffected by sewage. The ammonias present in sewage are very high, but in a thoroughly purified sewage effluent they may be no greater than in a good spring or well water.

The water of an unpolluted pond or reservoir containing a large quantity of ammonia, on account of the presence of organic matter of a vegetable origin, may, after passing through the ground to a filter-gallery or well, become nearly or quite as free from ammonia as the natural ground water of the region.

Some of the filter-galleries and wells located near streams and ponds have now been in use as public water supplies for many years. In some cases the quality of the water shows no material change from the time the first examination was made, but in other cases the quantity of free and albuminoid ammonia has increased, indicating that a part at least of the water entering these sources is imperfectly purified. In imperfectly purified waters the increase in ammonias is usually accompanied by an increase in iron and in nitrites, and later by the presence of turbidity, sediment and color.

Some ground waters are affected by the presence of organic matter in the ground from which they are drawn. A notable instance of this is the source of supply of the town of Provincetown, where the water drawn from the wells contains very large quantities of ammonia and iron, evidently derived from organic matter deeply buried in the ground in which the wells are located. Ground waters from beneath swamps or deep layers of peaty soil usually show similar characteristics. The quantity of albuminoid ammonia and free ammonia found in the various ground-water supplies of the State are given in the following tables, Nos. 27 and 28: —

TABLE No. 27. — *Albuminoid Ammonia in Ground Waters.*

[Parts per 100,000.]

Adams, tubular wells,	.0005
Mansfield, well,	.0005
Foxborough, tubular wells,	.0006
Walpole, tubular wells,	.0006
Manchester, large well,	.0007
Monson, well,	.0008
Shirley, well,	.0008
Groton, well,	.0009
Tisbury, spring,	.0009
Ware, well,	.0009
Canton, Springdale well,	.0010
Marshfield, well,	.0010
Scituate, wells,	.0010
Sharon, well,	.0010
Avon, well,	.0011
Needham, Hicks Spring,	.0011
Webster, well,	.0011
Sheffield, spring,	.0012
Wellesley, tubular wells,	.0012
Cottage City, springs,	.0013
Natick, well,	.0013
Needham, Well No. 1,	.0014
West Springfield, well,	.0014
Amesbury, Main Street wells,	.0015
Dracut, tubular wells,	.0015
Easton, well,	.0015
Kingston, tubular wells,	.0015
Manchester, tubular wells,	.0015
Dedham, tubular wells,	.0016
North Attleborough, well,	.0016
Cohasset, tubular wells No. 2,	.0017
Needham, Well No. 2,	.0017
Williamstown, Cold Spring,	.0017
Winchendon, well,	.0017
Ayer, well,	.0018
Hopkinton, tubular wells,	.0019
Millbury, well,	.0019
Cohasset, tubular wells No. 1,	.0020
Uxbridge, spring,	.0022
Canton, well near Henry's Spring,	.0023
Hingham, wells,	.0023
Millis, spring,	.0023
Wellesley, filter-gallery,	.0023
Wellesley, well at Williams Spring,	.0024
Billerica, tubular wells,	.0026
Marblehead, Well No. 1,	.0026
Amesbury, Market Street wells,	.0028
Grafton, filter-gallery,	.0029
Attleborough, well,	.0031
Bridgewater, wells,	.0031
Woburn, filter-gallery,	.0031
Lowell, Boulevard wells (tubular),	.0034
Marblehead, Well No. 2,	.0034
Medfield, spring,	.0034
Newton, tubular wells and filter-gallery,	.0034
Newburyport, wells,	.0036
Dedham, large well,	.0038
Brookline, tubular wells and filter-gallery,	.0041
Waltham, well,	.0041
Hyde Park, tubular wells near the Neponset River,	.0042
Williamstown, Sherman Spring,	.0045
Middleborough, well,	.0047
Lowell, Cook wells (tubular),	.0048
Hyde Park, tubular wells near Mother Brook,	.0049
Methuen, tubular wells,	.0049
Framingham, filter-gallery,	.0050
Leicester, wells,	.0050
Weston, well,	.0053
Nantucket, wells,	.0062
Braintree, filter-gallery,	.0078
Reading, filtered water,	.0081
Westborough, filter basin,	.0083
Cohasset, filter-gallery,	.0093
Fairhaven, tubular wells,	.0095
Holliston, well,	.0111
Reading, filter-gallery,	.0111
Franklin, wells,	.0156
Provincetown, well,	.0181

TABLE No. 28. — *Free Ammonia in Ground Waters.*

[Parts per 100,000.]

Adams, tubular wells,	.0001
Walpole, tubular wells,	.0001
Ware, well,	.0001
Canton, Springdale well,	.0002
Canton, well near Henry's Spring,	.0002
Foxborough, tubular wells,	.0002
Manchester, large well,	.0002
Mansfield, well,	.0002
Sharon, well,	.0002
Shirley, well,	.0002
Tisbury, spring,	.0002
Uxbridge, spring,	.0002
Cohasset, tubular wells No. 2,	.0003
Cottage City, springs,	.0003
Easton, well,	.0003
Grafton, filter-gallery,	.0003
Groton, well,	.0003
Hopkinton, tubular wells,	.0003
Millbury, well,	.0003
Millis, spring,	.0003
Monson, well,	.0003
Needham, Well No. 1,	.0003
Needham, Hicks Spring,	.0003
North Attleborough, well,	.0003
West Springfield, well,	.0003
Williamstown, Sherman Spring,	.0003
Marshfield, well,	.0004
Natick, well,	.0004
Needham, Well No. 2,	.0004
Newburyport, wells,	.0004
Sheffield, spring,	.0004
Webster, well,	.0004
Weston, well,	.0004
Williamstown, Cold Spring,	.0004
Avon, well,	.0005
Ayer, well,	.0005
Dracut, tubular wells,	.0005
Kingston, tubular wells,	.0005
Methuen, tubular wells,	.0005
Scituate, wells,	.0005
Attleborough, well,	.0006
Cohasset, tubular wells No. 1,	.0006
Medfield, spring,	.0006
Newton, tubular wells and filter-gallery,	.0006
Wellesley, filter-gallery,	.0006
Bridgewater, wells,	.0007
Hyde Park, tubular wells near Mother Brook,	.0007
Wellesley, well at Williams Spring,	.0007
Westborough, filter basin,	.0007
Fairhaven, tubular wells,	.0008
Holliston, well,	.0008
Manchester, tubular wells,	.0008
Billerica, tubular wells,	.0009
Hingham, wells,	.0009
Dedham, large well,	.0010
Dedham, tubular wells,	.0012
Winchendon, well,	.0015
Braintree, filter-gallery,	.0017
Amesbury, Main Street wells,	.0018
Wellesley, tubular wells,	.0019
Middleborough, well,	.0022
Leicester, wells,	.0028
Franklin, wells,	.0031
Waltham, well,	.0031
Lowell, Cook wells (tubular),	.0032
Framingham, filter-gallery,	.0033
Amesbury, Market Street wells,	.0036
Brookline, tubular wells and filter-gallery,	.0036
Lowell, Boulevard wells (tubular),	.0049
Nantucket, wells,	.0058
Woburn, filter-gallery,	.0062
Reading, filtered water,	.0066
Reading, filter-gallery,	.0101
Hyde Park, tubular wells near the Neponset River,	.0107
Marblehead, Well No. 1,	.0140
Provincetown, well,	.0148
Marblehead, Well No. 2,	.0260
Cohasset, filter-gallery,	.0591

Iron in Ground Waters.

Many ground waters contain iron in sufficient quantity to produce a rusty precipitate when the water is exposed to air, and the iron becomes oxidized. When iron is present to an amount equal to about .05 of a part per 100,000 it will usually precipitate, giving the water first a milky turbidity and subsequently a rusty sediment. In some ground waters this precipitation takes place rapidly, and the water subsequently becomes again clear and colorless, while in other cases the iron precipitates very slowly and can only be removed from the water within a reasonable time by some less simple method. The quantity of iron varies greatly at different seasons of the year in most of those waters in which it is present in considerable quantity, being insignificant in some seasons, while in others it is present in sufficient quantity to cause serious trouble. The quantity of iron present in the various waters is shown in the following table: —

Table No. 29. — *Iron in Ground Waters.*

[Parts per 100,000.]

Adams, tubular wells,	.0035
Wellesley, filter-gallery,	.0038
Mansfield, well,	.0039
Needham, Well No. 1,	.0041
Avon, well,	.0045
Manchester, tubular wells,	.0045
Medfield, spring,	.0046
Woburn, filter-gallery,	.0046
Needham, Well No. 2,	.0047
Ware, well,	.0047
Natick, well,	.0051
Easton, well,	.0052
Millbury, well,	.0052
Millis, spring,	.0055
Sharon, well,	.0057
Monson, well,	.0058
Needham, Hicks Spring,	.0058
Groton, well,	.0059
Wellesley, well at Williams Spring,	.0059
Dedham, large well,	.0060
Dracut, tubular wells,	.0061
Canton, well near Henry's Spring,	.0063
West Springfield, well,	.0064
Newton, tubular wells and filter-gallery,	.0067
Grafton, filter-gallery,	.0068
Hyde Park, tubular wells near Mother Brook,	.0069
Attleborough, well,	.0070
Williamstown, Sherman Spring,	.0070
Foxborough, tubular wells,	.0072
Manchester, large well,	.0073
Williamstown, Cold Spring,	.0073
Kingston, tubular wells,	.0074
Sheffield, spring,	.0076
Weston, well,	.0076
Walpole, tubular wells,	.0077
Marshfield, well,	.0078
Canton, Springdale well,	.0079
Cohasset, tubular wells No. 2,	.0079
Webster, well,	.0079
Wellesley, tubular wells,	.0079
Braintree, filter-gallery,	.0083
Ayer, well,	.0088
Scituate, wells,	.0088
North Attleborough, well,	.0089
Amesbury, Market Street wells,	.0094
Hopkinton, tubular wells,	.0094
Dedham, tubular wells,	.0102
Shirley, well,	.0106
Tisbury, spring,	.0111

TABLE No. 29.— *Iron in Ground Waters* — Concluded.

[Parts per 100,000.]

Reading, filtered water,	.0121	Lowell, Cook wells (tubular),	.0297
Brookline, tubular wells and filter-gallery,	.0128	Billerica, tubular wells,	.0327
Cottage City, springs,	.0133	Hyde Park, tubular wells near the Neponset River,	.0341
Framingham, filter-gallery,	.0133	Fairhaven, tubular wells,	.0356
Cohasset, filter-gallery,	.0134	Lowell, Boulevard wells (tubular),	.0360
Leicester, wells,	.0164	Newburyport, wells,	.0367
Franklin, wells,	.0169	Amesbury, Main Street wells,	.0570
Hingham, wells,	.0170	Middleborough, well,	.0622
Winchendon, well,	.0178	Bridgewater, wells,	.0649
Methuen, tubular wells,	.0210	Marblehead, Well No. 1,	.1895
Cohasset, tubular wells No. 1,	.0215	Reading, filter-gallery,	.1972
Nantucket, wells,	.0235	Marblehead, Well No. 2,	.3868
Waltham, well,	.0236	Provincetown, well,	.4647
Holliston, well,	.0266		

HARDNESS OF GROUND WATERS.

The remarks concerning the hardness of surface waters apply also to ground waters. Unpolluted ground waters in most parts of the State are soft, but they are apparently somewhat harder than unpolluted surface waters of the same region. The harder waters are found in the limestone regions located chiefly in the western part of the State and in thickly populated localities where the ground water is affected by sewage and other wastes. Half the ground waters of the State have a hardness of less than 2.5 parts per 100,000, and only 11 have a hardness of more than 5 parts per 100,000. The hardness of the filtered water supplied to the town of Reading is greatly increased by the lime and alum used in the process of purifying this water, which contains an excessive quantity of iron.

TABLE No. 30.— *Hardness of Ground Waters.*

[Parts per 100,000.]

Uxbridge, spring,	0.4	Avon, well,	1.1
Mansfield, well,	0.5	Walpole, tubular wells,	1.1
Tisbury, spring,	0.5	Westborough, filter basin,	1.1
Cottage City, springs,	0.6	Canton, well near Henry's Spring,	1.2
Foxborough, tubular wells,	0.7	Holliston, well,	1.2
Shirley, well,	0.7	Webster, well,	1.4
Kingston, tubular wells,	0.9	Easton, well,	1.5
Winchendon, well,	0.9	Needham, Hicks Spring,	1.5
Canton, Springdale well,	1.0	Lowell, Boulevard wells (tubular),	1.6
Medfield, spring,	1.0	Nantucket, wells,	1.6
Monson, well,	1.0	Braintree, filter-gallery,	1.7

TABLE NO. 30. — *Hardness of Ground Waters* — Concluded.

[Parts per 100,000.]

Dracut, tubular wells,	1.7
Attleborough, well,	1.8
Fairhaven, tubular wells,	1.9
Groton, well,	1.9
Sheffield, spring,	1.9
Hingham, wells,	2.0
Needham, Well No. 1,	2.0
Franklin, wells,	2.1
Ayer, well,	2.2
Billerica, tubular wells,	2.3
Bridgewater, wells,	2.3
Marshfield, well,	2.3
Middleborough, well,	2.3
Needham, Well No. 2,	2.3
Leicester, wells,	2.4
Newburyport, wells,	2.4
Manchester, tubular wells,	2.5
West Springfield, well,	2.5
Newton, tubular wells and filter-gallery,	2.6
Millbury, well,	2.7
Millis, spring,	2.8
Provincetown, well,	2.8
Wellesley, filter-gallery,	2.8
North Attleborough, well,	2.9
Reading, filter-gallery,	2.9
Ware, well,	2.9
Weston, well,	3.0
Hyde Park, tubular wells near Mother Brook,	3.1
Wellesley, tubular wells,	3.3
Methuen, tubular wells,	3.4
Waltham, well,	3.4
Sharon, well,	3.5
Wellesley, well at Williams Spring,	3.5
Lowell, Cook wells (tubular),	3.6
Grafton, filter-gallery,	3.7
Manchester, large well,	3.7
Dedham, large well,	3.8
Framingham, filter-gallery,	3.8
Natick, well,	4.3
Amesbury, Main Street wells,	4.4
Hyde Park, tubular wells near the Neponset River,	4.4
Scituate, wells,	4.5
Brookline, tubular wells and filter-gallery,	4.6
Hopkinton, tubular wells,	4.6
Woburn, filter-gallery,	4.8
Cohasset, filter-gallery,	5.1
Dedham, tubular wells,	5.4
Cohasset, tubular wells No. 2,	5.6
Cohasset, tubular wells No. 1,	6.0
Williamstown, Sherman Spring,	6.4
Marblehead, Well No. 2,	6.8
Marblehead, Well No. 1,	7.0
Reading, filtered water,	8.8
Adams, tubular wells,	9.7
Williamstown, Cold Spring,	10.7
Amesbury, Market Street wells,	11.7

RESIDUE ON EVAPORATION IN GROUND WATERS.

The remarks concerning the presence of dissolved mineral matter in surface waters apply also to ground waters. The highest residues in unpolluted ground waters are found in the limestone regions and in wells near the sea, and the high total residue in other places is usually an indication of the previous pollution of the water by sewage. About half the ground waters of the State have a total residue of less than 6.5 parts per 100,000, and in 75 per cent. of the waters the total residue is less than 10 parts per 100,000. The total residue in the various ground-water supplies of the State is shown by the following table: —

TABLE No. 31. — *Residue on Evaporation in Ground Waters.*

[Parts per 100,000.]

Uxbridge, spring,	2.44	Nantucket, wells,	7.00
Shirley, well,	2.45	Wellesley, filter-gallery,	7.00
Mansfield, well,	2.72	West Springfield, well,	7.12
Westborough, filter basin,	2.82	Waltham, well,	7.14
Winchendon, well,	3.05	Millis, spring,	7.22
Monson, well,	3.23	Methuen, tubular wells,	7.63
Sheffield, spring,	3.46	Wellesley, tubular wells,	7.63
Foxborough, tubular wells,	3.58	Natick, well,	8.05
Canton, Springdale well,	3.61	Framingham, filter-gallery,	8.17
Avon, well,	3.70	Hyde Park, tubular wells near Mother Brook,	8.18
Webster, well,	3.75	Ware, well,	8.19
Holliston, well,	3.80	Reading, filter-gallery,	8.83
Medfield, spring,	3.85	Lowell, Cook wells (tubular),	8.86
Cottage City, springs,	3.89	Dedham, large well,	8.97
Walpole, tubular wells,	3.92	Brookline, tubular wells and filter-gallery,	9.02
Canton, well near Henry's Spring,	3.94	Sharon, well,	9.26
Attleborough, well,	4.02	Williamstown, Sherman Spring,	9.52
Lowell, Boulevard wells (tubular),	4.16	Wellesley, well at Williams Spring,	9.67
Tisbury, spring,	4.25	Woburn, filter-gallery,	9.68
Groton, well,	4.31	Manchester, tubular wells,	9.73
Easton, well,	4.43	Grafton, filter-gallery,	10.27
Dracut, tubular wells,	4.60	Amesbury, Main Street wells,	10.33
Kingston, tubular wells,	4.60	Hyde Park, tubular wells near the Neponset River,	10.37
Needham, Hicks Spring,	4.63	Provincetown, well,	10.78
Braintree, filter-gallery,	5.09	Cohasset, filter-gallery,	11.14
Hingham, wells,	5.27	Manchester, large well,	11.15
Ayer, well,	5.51	Hopkinton, tubular wells,	11.52
Needham, Well No. 1,	5.62	Marshfield, well,	11.88
Newton, tubular wells and filter-gallery,	6.02	Williamstown, Cold Spring,	13.12
Millbury, well,	6.05	Cohasset, tubular wells No. 1,	13.24
Newburyport, wells,	6.06	Cohasset, tubular wells No. 2,	13.54
Leicester, wells,	6.11	Adams, tubular wells,	13.60
Middleborough, well,	6.17	Dedham, tubular wells,	13.97
Needham, Well No. 2,	6.24	Reading, filtered water,	15.26
Fairhaven, tubular wells,	6.36	Scituate, wells,	15.45
North Attleborough, well,	6.36	Marblehead, Well No. 1,	16.99
Franklin, wells,	6.43	Marblehead, Well No. 2,	17.26
Billerica, tubular wells,	6.50	Amesbury, Market Street wells,	25.09
Weston, well,	6.83		
Bridgewater, wells,	6.91		

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

In the report for the year 1902, in the chapter entitled "Report upon the Examinations of the Outlets of Sewers and the Effect of Sewage Disposal in Massachusetts," the results of the investigation made in that year of the sources of pollution of streams in the State are presented in much detail, together with the results of analyses of the waters of these streams for a long series of years.

During the year 1904 the condition of the various streams has been observed as usual, but the flow of the streams during this year has not been low, and there has been no material change in the condition of the various polluted streams, so that the results of the examinations which have been made are not presented in detail.

Chemical analyses of samples of water from the following streams have been made at frequent intervals during the year: —

Blackstone.	Nemasket.	Stillwater.
Charles.	Neponset.	Sudbury.
Merrimack.	Quinepoxet.	Westfield.
Nashua.	Saugus.	

The waters of the following streams have been examined during the summer months only: —

Assabet.	Housatonic.	Salisbury Plain.
Chicopee.	Manhan.	Seven Mile.
Concord.	Mill (Northampton).	Shawsheen.
Connecticut.	Miller's.	Spicket.
Deerfield.	Mumford.	Taunton.
French.	Quaboag.	Ten Mile.
Green.	Quinebaug.	Three Mile.
Hoosick.	Rumford.	Ware.

A summary of the various analyses, showing the condition of the Blackstone and Merrimack rivers at several points, is appended.

BLACKSTONE RIVER.

Blackstone River.

Chemical Examination of Water from the Blackstone River. — Averages for Six Months, from June to November, 1887 to 1904, inclusive.

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts per 100,000.]

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887, . .	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
" " 1888, . .	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
" " 1889, . .	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
" " 1890, . .	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891, . .	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
" " 1892, . .	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893, . .	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894, . .	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
" " 1895, . .	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
" " 1896, . .	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
" " 1897, . .	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2
" " 1898, . .	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
" " 1899, . .	0.14	34.38	10.60	.2583	.0788	.0390	.0398	-	-	.0004	14.3
" " 1900, . .	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
" " 1901, . .	0.23	31.03	11.63	.1410	.0548	.0309	.0239	-	-	.0023	13.8
" " 1902, . .	0.10	46.15	12.47	.2453	.0728	.0274	.0454	-	-	.0010	16.5
" " 1903, . .	0.18	24.06	6.80	.2836	.0750	.0472	.0278	-	-	.0027	8.4
" " 1904, . .	0.12	44.68	17.08	.1228	.0434	.0225	.0209	-	-	.0008	14.7

Blackstone River, below Sewage Precipitation Works.

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887, . .	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
" " 1888, . .	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
" " 1889, . .	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
" " 1890, . .	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
" " 1891, . .	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
" " 1892, . .	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893, . .	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894, . .	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895, . .	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
" " 1896, . .	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
" " 1897, . .	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
" " 1898, . .	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
" " 1899, . .	0.14	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108	.0068	16.1
" " 1900, . .	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
" " 1901, . .	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8
" " 1902, . .	0.15	49.62	13.38	.7296	.1284	.0736	.0548	2.97	-	.0033	12.5
" " 1903, . .	0.39	31.08	9.48	.3880	.1080	.0545	.0535	-	-	.0062	10.4
" " 1904, . .	-	50.25	13.73	.6381	.1523	.0601	.0922	-	-	.0027	16.9

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM THE BLACKSTONE RIVER, ETC.— *Concluded.*

Blackstone River, at Uxbridge.

[Parts per 100,000.]

Months.	Color.	Residue on Evaporation.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.		Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887,	.39	-	-	.1129	.0271	-	-	0.79	.0360	-	-
" " 1888,	.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	-
" " 1889,	.32	-	-	.1133	.0296	.0192	.0104	0.66	.0333	.0009	-
" " 1890,	.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
" " 1891,	.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
" " 1892,	.13	9.86	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
" " 1893,	.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
" " 1894,	.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
" " 1895,	.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
" " 1896,	.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
" " 1897,	.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
" " 1898,	.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
" " 1899,	.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
" " 1900,	.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
" " 1901,	.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0
" " 1902,	.15	14.17	2.56	.3462	.0270	.0218	.0052	1.95	.0210	.0018	4.9
" " 1903,	.30	13.16	2.52	.3030	.0262	.0215	.0047	1.74	.0210	.0024	4.4
" " 1904,	.20	13.78	2.74	.2399	.0282	.0214	.0068	2.12	.0408	.0022	4.6

Blackstone River, at Millville.

Months.	Color.	Residue on Evaporation: Total.	Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia: Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
June-Nov., 1887,	.31	-	-	.0468	.0220	-	-	0.51	.0210	-	-
" " 1888,	.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	-
" " 1889,	.38	-	-	.0499	.0273	.0213	.0060	0.45	.0167	.0008	-
" " 1890,	.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
" " 1891,	.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
" " 1892,	.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
" " 1893,	.23	7.48	1.73	.0677	.0119	.0087	.0032	0.77	.0385	.0011	2.6
" " 1894,	.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
" " 1895,	.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
" " 1896,	.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0418	.0027	3.3
" " 1897,	.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
" " 1898,	.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
" " 1899,	.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
" " 1900,	.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
" " 1901,	.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1
" " 1902,	.28	9.43	2.24	.1623	.0284	.0238	.0046	1.20	.0195	.0010	2.8
" " 1903,	.33	8.46	1.85	.1397	.0233	.0189	.0044	1.10	.0192	.0010	2.9
" " 1904,	.29	8.71	2.06	.1079	.0235	.0201	.0034	1.26	.0337	.0009	2.9

NOTE.—The sewage purification works of the city of Worcester were put in operation in 1890, since which time a portion of the sewage of the city has been treated. The works were enlarged in 1893, and since that time practically all of the dry-weather flow of sewage has been treated.

MERRIMACK RIVER.

Table comparing the Analyses above Lowell with those above Lawrence, 1904.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
Mean of analyses above Lowell, .	.30	4.25	1.77	.0072	.0191	.0146	.0045	.22	.0054	.0002	1.2
Mean of analyses above Lawrence, .	.32	4.56	1.83	.0164	.0238	.0172	.0066	.32	.0050	.0003	1.3
Increase, ...	.02	0.31	0.06	.0092	.0047	.0026	.0021	.10	.0004*	.0001	0.1

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years.

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts per 100,000.]

Date.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
Increase, 1887-1889, .	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003*	.0000	-
Increase, 1890, . .	0.05	0.62	0.22*	.0016	.0023	.0017	.0006	.028	.0020*	.0000	0.2
Increase, 1891, . .	0.02*	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030*	.0000	0.1
Increase, 1892, . .	0.06	0.48	0.12	.0019	.0037	.0037	.0000	.039	.0013*	.0000	0.0
Increase, 1893, . .	0.09	0.47	0.30	.0031	.0032	.0021	.0011	.035	.0002*	.0001	0.0
Increase, 1894, . .	0.02	0.15	0.04	.0028	.0032	.0032	.0000	.049	.0000	.0000	0.1
Increase, 1895, . .	0.11	0.52	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896, . .	0.02	0.51	0.24	.0034	.0058	.0047	.0006	.070	.0017	.0002	0.2
Increase, 1897, . .	0.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1
Increase, 1898, . .	0.03	0.37	0.07	.0024	.0039	.0019	.0020	.044	.0010	.0002	0.1
Increase, 1899, . .	0.02	0.39	0.07	.0038	.0045	.0023	.0022	.059	.0004*	.0001	0.1
Increase, 1900, . .	0.03	0.41	0.11	.0037	.0027	.0026	.0001	.055	.0011	.0000	0.0
Increase, 1901, . .	0.03	0.27	0.03	.0032	.0044	.0023	.0021	.053	.0020	.0003	0.3
Increase, 1902, . .	0.03	0.52	0.20	.0032	.0063	.0027	.0036	.060	.0000	.0001	0.1
Increase, 1903, . .	0.04	0.56	0.18	.0043	.0065	.0045	.0020	.072	.0014	.0002	0.2
Increase, 1904, . .	0.02	0.31	0.06	.0092	.0047	.0026	.0021	.100	.0004*	.0001	0.1

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,434, 8,126, 5,459, 11,634, 5,886, 8,230, 9,402, 7,406, 7,389, 8,524, 9,160, 9,674 and 7,410 cubic feet per second.

* Decrease.

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

WATER SUPPLY STATISTICS.

At the end of the year 1904 all of the 33 cities in Massachusetts and 147 of the 320 towns were provided with public water supplies. The following table gives a classification by population of the cities and towns having and not having public water supplies Dec. 31, 1904, the population being taken from the census of 1900: —

POPULATION (1900).	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having a Public Water Supply.	Total Population of Places in Preceding Column.
Under 500,	-	-	87	13,383
500-999,	5	4,349	48	37,098
1,000-1,499,	13	16,167	34	41,262
1,500-1,999,	14	25,027	28	47,535
2,000-2,499,	12	26,560	12	26,872
2,500-2,999,	8	21,681	5	13,672
3,000-3,499,	11	35,221	2	6,817
3,500-3,999,	9	33,123	5	18,590
4,000-4,499,	7	29,878	1	4,364
4,500-4,999,	9	42,170	-	-
Above 5,000,	92	2,355,861	1	5,721
Totals,	180	2,590,037	173	215,309

All of the towns having a population, according to the census of 1900, in excess of 6,000 are supplied with water, and there are only 9 towns in the State which have a population in excess of 3,000 which are not provided with public water supplies. These towns are as follows: —

TOWN.	Population in 1900.	TOWN.	Population in 1900.
Blackstone,	5,721	Dartmouth,	3,669
Barnstable,	4,364	Dudley,	3,553
Chelmsford,	3,984	Templeton,	3,489
Pepperell,	3,701	Sutton,	3,328
Tewksbury,	3,683		

In all of the cities and 96 of the towns the water works are owned either by the municipality or by a fire or water supply district. In 51 towns the works are owned by private companies. The following table gives a classification by population of the cities and towns which own their water works and those which are supplied with water by private companies: —

POPULATION (1900).	Number of Places of Given Population owning Water Works.	Total Population of Places in Preceding Column.	Number of Places of Given Population supplied with Water by Private Companies.	Total Population of Places in Preceding Column.
Under 1,000,	3	2,623	2	1,726
1,000-1,999,	15	23,478	12	17,716
2,000-2,999,	10	23,731	10	24,510
3,000-3,999,	12	41,726	8	26,618
4,000-4,999,	13	58,302	3	13,746
5,000-5,999,	13	70,870	5	25,923
6,000-6,999,	6	38,778	1	6,058
7,000-7,999,	7	52,254	4	29,855
Above 8,000,	50	2,066,808	6	65,815
Totals,	129	2,378,570	51	211,467

NOTE. — Since Jan. 1, 1905, the ownership of the water works in Athol, population 7,061, Revere, population 10,395, and Tisbury, population 1,149, has changed from private to public; and the towns of Amesbury, population 9,473, Framingham, population 11,302, and Winthrop, population 6,058, have voted to take the works of the water companies in those places.

From the totals given in the above tables it will be seen that the population of those towns supplied with water by private companies is only 8.2 per cent. of the total population in all the cities and towns supplied with water, and that there are at the end of the year 1904 only 6 towns having a population above 8,000 which are supplied by private companies.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped, and in several cities and towns Venturi meters are used to measure the quantity supplied. A summary of these statistics for the year 1904 is given in the following table. The estimated population given in the table is obtained by adding four-fifths of the increase in population from 1895 to 1900 to the population as determined by the census in the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated population. The quantity obtained in this manner varies somewhat in the actual consumption per person using the water, as in many cities and towns there is a considerable number of people who do not use the public water supply, while in some of the towns used as summer resorts the population using the water during the summer months is much greater than the population shown by the census. With a few exceptions, however, the error is not large.

Statistics relating to the Consumption of Water in Various Cities and Towns.

City or Town.	Estimated Population in 1904.	Average Daily Consumption (Gallons), 1904.	Daily Consumption per Inhabitant (Gallons), 1904.	City or Town.	Estimated Population in 1904.	Average Daily Consumption (Gallons), 1904.	Daily Consumption per Inhabitant (Gallons), 1904.
Metropolitan Water District.*	928,770	118,922,000	123	Fairhaven, . .	3,750	336,000	90
Boston, . . .	611,830	87,680,000	143	Fall River, . .	117,391	4,092,000	35
Somerville, . .	70,320	6,228,000	89	Falmouth, . .	4,176	203,000	49
Malden, . .	40,825	1,868,000	46	Foxborough, . .	3,304	195,000	59
Chelsea, . .	37,335	4,260,000	113	Franklin, . . .	4,921	209,000	43
Everett, . .	29,370	2,624,000	89	Gardner, . . .	12,117	910,000	75
Quincy, . . .	27,830	2,823,000	101	Gloucester, . .	24,449	1,114,000	46
Medford, . .	22,125	1,803,000	81	Groton, . . .	1,940	57,000	29
Melrose, . .	14,445	1,525,000	106	Holliston, . . .	2,502	28,000	11
Revere, . . .	13,710	933,000	68	Hyde Park, . .	14,378	1,015,000	71
Watertown, . .	11,250	624,000	55	Ipswich, . . .	4,610	120,000	26
Arlington, . .	10,150	752,000	74	Lancaster, . .	2,718	73,000	27
Milton, . . .	7,740	316,000	41	Lawrence, . .	70,875	2,834,000	40
Winthrop, . .	7,770	742,000	96	Lincoln, . . .	1,140	162,000	142
Stoneham, . .	6,420	558,000	87	Lowell, . . .	103,451	5,485,000	53
Belmont, . .	5,045	249,000	49	Lynn and Saugus, .	78,993	5,338,000	67
Lexington, . .	3,620	283,000	78	Manchester, . .	3,039	279,000	92
Nahant, . . .	2,310	131,000	57	Mansfield, . .	4,234	187,000	44
Swampscott, . .	6,170	521,000	84	Marblehead, . .	7,511	552,000	73
Abington and Rockland.	9,884	431,000	44	Marlborough, . .	12,515	605,000	48
Andover, . . .	7,347	394,000	54	Maynard, . . .	3,182	276,000	87
Attleborough, . .	13,771	554,000	40	Methuen, . . .	8,970	313,000	35
Avon, . . .	1,833	78,000	43	Middleborough, .	7,042	255,000	36
Ayer, . . .	2,722	109,000	40	Milford and Hopedale.	15,963	872,000	55
Beverly, . . .	15,548	1,225,000	79	Millbury, . . .	3,851	187,000	49
Billerica, . . .	2,931	102,000	35	Montague, . .	6,224	577,000	93
Braintree, . .	6,517	592,000	91	Nantucket, . .	2,998	136,000	45
Bridgewater and East Bridgewater.	9,832	214,000	22	Natick, . . .	10,027	519,000	52
Brockton, . .	45,581	1,588,000	35	Needham, . .	4,420	274,000	62
Brookline, . .	22,952	2,348,000	102	New Bedford, . .	68,195	7,022,000	103
Cambridge, . .	100,080	8,847,000	88	Newburyport, . .	14,418	743,000	52
Canton, . . .	4,542	288,000	63	Newton, . . .	38,385	2,188,000	57
Clinton, . . .	15,403	532,000	35	North Andover, .	4,783	150,000	31
Danvers and Middleton.	9,671	787,000	81	North Attleborough,	7,795	300,000	38
Dedham, . . .	7,654	1,041,000	136	North Brookfield, .	4,547	151,000	33
Easton, . . .	5,145	125,000	24	Norwood, . . .	6,205	433,000	70

* The figures given for the cities and towns in the Metropolitan Water District are taken from the report of the Metropolitan Water and Sewerage Board.

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Estimated Population in 1904.	Average Daily Consumption (Gallons), 1904.	Daily Consumption per Inhabitant (Gallons), 1904.	City or Town.	Estimated Population in 1904.	Average Daily Consumption (Gallons), 1904.	Daily Consumption per Inhabitant (Gallons), 1904.
Orange,	5,647	155,000	27	Wakefield,	10,079	655,000	65
Peabody,	12,335	1,666,000	135	Walpole,	4,036	314,000	78
Provincetown,	4,001	124,000	31	Waltham,	25,565	2,073,000	81
Randolph and Holbrook.	6,406	257,000	40	Ware,	8,758	350,000	40
Reading,	5,171	154,000	30	Wareham,	3,484	32,000	9
Rockport,	4,036	327,000	81	Webster,	9,608	305,000	32
Rutland,	1,619	95,000	59	Wellesley,	5,748	313,000	54
Salem,	37,144	3,165,000	85	Weston,	1,983	67,000	35
Sharon,	2,386	79,000	34	Whitman,	6,488	163,000	25
Shirley,	1,904	18,000	10	Winchendon,	5,409	98,000	18
Stoughton,	5,578	365,000	65	Woburn,	14,314	1,425,000	99
Taunton,	34,172	1,771,000	52	Worcester,	134,145	10,221,000	76
Tisbury,	1,265	69,000	54				

Rainfall.

The average rainfall in Massachusetts, as deduced from long-continued observations in various parts of the State, is 45.49 inches. The average rainfall for the year 1904 in these places was 43.81 inches, making a deficiency of 1.68 inches. There was an excess of rainfall in January, April, June and September, and a deficiency during the remaining eight months. The greatest excess in any one month occurred in April, when the rainfall was 8.06 inches. The greatest deficiency occurred in October and November, when the rainfall was 1.78 and 1.83 inches respectively.

The following table gives the normal rainfall in the State for each month, as deduced from the observations at various places for a long period of years, together with the average rainfall at those places for each month during 1904, and the departures from the normal: —

Month.	Normal Rainfall (Inches).	Rainfall 1904 (Inches).	Excess or Deficiency 1904 (Inches).	Month.	Normal Rainfall (Inches).	Rainfall 1904 (Inches).	Excess or Deficiency 1904 (Inches).
January,	3.90	4.80	+0.90	August,	4.27	4.20	—0.07
February,	3.77	3.01	—0.76	September,	3.39	5.28	+1.89
March,	4.15	3.03	—1.12	October,	4.01	1.78	—2.23
April,	3.60	8.06	+4.46	November,	3.98	1.83	—2.15
May,	3.67	3.36	—0.31	December,	3.68	2.92	—0.76
June,	3.28	3.49	+0.21	Total,	45.49	43.81	—1.68
July,	3.79	2.05	—1.74				

Flow of Streams.

The flow of streams for the year 1904, as indicated by the records of the Sudbury River, was less than the normal. The flow was in excess of the normal during the months of March, April, May and September, and below the normal during the remaining months. The greatest excess occurred in April and the greatest deficiency in February. In order to show the relation between the flow of the Sudbury River during each month of 1904 and the normal flow of that stream, as deduced from observations during thirty years, from 1875 to 1904, inclusive, the following table has been prepared. The area of the water-shed of the Sudbury River above the point of measurement is 75.2 square miles.

Month.	Normal Flow.		Actual Flow for 1904.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.882	1.217	0.738	0.477	−1.144	−0.740
February,	2.879	1.861	1.365	0.882	−1.514	−0.979
March,	4.620	2.986	4.640	2.999	+0.020	+0.013
April,	3.273	2.116	5.096	3.294	+1.823	+1.178
May,	1.766	1.141	2.699	1.745	+0.933	+0.604
June,	0.807	0.522	0.648	0.419	−0.159	−0.103
July,	0.299	0.193	0.096	0.062	−0.203	−0.131
August,	0.450	0.291	0.262	0.170	−0.280	−0.121
September,	0.368	0.238	0.614	0.397	+0.246	+0.159
October,	0.327	0.506	0.295	0.191	−0.032	−0.315
November,	1.343	0.868	0.447	0.289	−0.896	−0.579
December,	1.675	1.082	0.417	0.269	−1.258	−0.813
	1.673	1.081	1.441	0.931	−0.232	−0.150

The next table shows the weekly fluctuation during 1904 in the flow of three streams which were carefully measured, namely, the Sudbury, the south branch of the Nashua and the Merrimack rivers. The flow of these streams, particularly the Sudbury and the south branch of the Nashua, serves to indicate the flow of other streams in eastern Massachusetts. The flow of the Merrimack River is affected to some extent by the diversion of water from two of its tributaries for the water supply of the metropolitan district. The quantity diverted in 1904 amounted to about 178 cubic feet per second, which would reduce the figures given for the flow per square mile of water-shed about .038 of a cubic foot per second. The water-shed of the Sudbury River is 75.2 square miles, of the Nashua 119 square miles, and of the Merrimack 4,664 square miles.

Week ending Sunday.	Flow in Cubic Feet per Second per Square Mile of Water-shed.			Week ending Sunday.	Flow in Cubic Feet per Second per Square Mile of Water-shed.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
1904.				1904.			
Jan. 3, . .	0.602	0.944	0.668	July 3, . .	0.477	0.998	0.769
10, . .	0.777	0.806	0.563	10, . .	0.299	1.215	0.805
17, . .	0.954	0.974	0.588	17, . .	—0.094	0.527	0.549
24, . .	0.981	1.227	0.561	24, . .	—0.092	0.515	0.488
31, . .	0.262	1.184	0.583	31, . .	0.267	0.547	0.449
Feb. 7, . .	1.382	1.021	0.588	Aug. 7, . .	0.389	0.698	0.480
14, . .	0.831	0.687	0.564	14, . .	0.242	0.584	0.472
21, . .	1.099	0.679	0.544	21, . .	0.643	0.695	0.470
28, . .	2.564	2.958	0.764	28, . .	0.023	0.409	0.773
Mar. 6, . .	2.514	2.591	0.893	Sept. 4, . .	—0.016	0.181	0.452
13, . .	7.092	6.894	2.357	11, . .	0.022	0.278	0.404
20, . .	3.525	2.597	1.781	18, . .	1.725	1.966	0.810
27, . .	6.076	6.977	3.423	25, . .	0.557	0.471	0.711
Apr. 3, . .	4.251	4.412	5.330	Oct. 2, . .	0.425	0.584	0.855
10, . .	4.780	4.099	4.442	9, . .	0.083	0.436	0.739
17, . .	4.129	3.696	5.257	16, . .	0.428	0.471	0.611
24, . .	2.070	2.437	3.023	23, . .	0.587	0.728	0.732
May 1, . .	10.100	7.664	5.788	30, . .	0.436	0.564	0.931
8, . .	3.297	2.847	4.905	Nov. 6, . .	0.309	0.333	0.629
15, . .	3.331	2.497	3.099	13, . .	0.195	0.423	0.520
22, . .	2.462	2.367	4.124	20, . .	1.142	0.615	0.587
29, . .	1.077	1.458	2.527	27, . .	—0.335	0.681	0.587
June 5, . .	0.997	1.469	1.353	Dec. 4, . .	0.295	0.686	0.507
12, . .	1.161	2.103	1.405	11, . .	0.213	0.623	0.421
19, . .	0.292	0.865	0.895	18, . .	0.639	0.285	0.357
26, . .	0.384	0.565	0.621	25, . .	0.151	0.493	0.330

The following table gives the rainfall upon the Sudbury River water-shed and the total yield of the water-shed expressed in inches in depth on the water-shed (inches of rainfall collected) for the year 1904, together with the average of the records of thirty years, from 1875 to 1904, inclusive: —

Rainfall in Inches, received and collected on Sudbury Water-shed.

Month.	1904.			Mean for 30 Years. 1875-1904.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	4.87	0.851	17.5	4.21	2.170	51.6
February,	3.00	1.472	49.0	4.34	3.023	69.7
March,	2.72	5.349	196.8	4.59	5.326	116.0
April,	8.87	5.685	64.0	3.61	3.652	101.2
May,	2.65	3.112	117.7	3.34	2.036	60.9
June,	2.80	0.723	25.8	3.09	0.901	29.2
July,	1.96	0.111	5.6	3.67	0.345	9.4
August,	3.86	0.303	7.8	4.06	0.519	12.8
September,	5.80	0.685	11.8	3.32	0.411	12.4
October,	1.64	0.348	21.2	4.23	0.903	21.4
November,	1.73	0.499	28.8	3.96	1.500	37.9
December,	2.92	0.481	16.5	3.81	1.931	50.6
Totals and averages,	42.82	19.619	45.8	46.22	22.717	49.2

The Sudbury River records are particularly valuable as a basis for estimating the yield of other water-sheds in Massachusetts, both on account of the accuracy with which the measurements have been made, and the absence of abnormal conditions which would unfavorably affect the results.

The following table gives the records of the yield of this water-shed for each year of the past thirty years, the flow from the water-shed being expressed in gallons per day per square mile of water-shed, in order to render the table more convenient for use in estimating the probable yield of water-sheds used as sources of water supply: —

*Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile.**

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000	415,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000	4,004,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000	1,546,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000	965,000
June,	870,000	222,000	597,000	506,000	413,000	176,000	1,338,000
July,	321,000	183,000	202,000	128,000	158,000	177,000	276,000
August,	396,000	405,000	121,000	475,000	395,000	119,000	148,000
September,	207,000	184,000	60,000	160,000	141,000	80,000	197,000
October,	646,000	234,000	632,000	516,000	71,000	101,000	186,000
November,	1,302,000	1,088,000	1,418,000	1,698,000	206,000	205,000	395,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000	775,000
Av. for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000
Av. for driest six months,	574,000	384,000	502,000	582,000	230,000	143,000	330,000

Month.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
January,	1,241,000	335,000	995,000	1,235,000	1,461,000	2,589,000	1,053,000	2,782,000
February,	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000	2,829,000	1,951,000	1,195,000
March,	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000	3,237,000	1,339,000
April,	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000	2,645,000	1,410,000
May,	1,292,000	938,000	1,030,000	1,336,000	720,000	1,009,000	1,632,000	880,000
June,	529,000	300,000	417,000	426,000	203,000	414,000	422,000	653,000
July,	86,000	115,000	224,000	62,000	115,000	114,000	117,000	633,000
August,	55,000	78,000	257,000	240,000	94,000	214,000	380,000	1,432,000
September,	306,000	91,000	44,000	121,000	118,000	111,000	1,155,000	824,000
October,	299,000	186,000	83,000	336,000	146,000	190,000	1,999,000	1,230,000
November,	210,000	205,000	175,000	1,178,000	673,000	368,000	2,758,000	1,941,000
December,	314,000	193,000	925,000	1,174,000	1,020,000	643,000	3,043,000	2,241,000
Av. for whole year,	862,000	583,000	1,129,000	901,000	1,087,000	1,154,000	1,697,000	1,383,000
Av. for driest six months,	211,000	145,000	200,000	391,000	223,000	234,000	953,000	944,000

* The area of the Sudbury River water-shed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The water-shed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile — Concluded.

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
January,	1,254,000	3,018,000	1,870,000	433,000	698,000	1,084,000	1,084,000	845,000
February,	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000
March,	3,643,000	4,458,000	1,955,000	3,245,000	2,288,000	2,410,000	3,835,000	2,565,000
April,	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000
May,	1,366,000	582,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000
June,	568,000	414,000	428,000	440,000	419,000	174,000	399,000	962,000
July,	108,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000
August,	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000
September,	458,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000
October,	2,272,000	210,000	126,000	221,000	374,000	1,379,000	592,000	94,000
November,	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000
December,	997,000	544,000	485,000	797,000	716,000	1,782,000	657,000	1,584,000
Av. for whole year,	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000
Av. for driest six months,	747,000	239,000	327,000	287,000	356,000	460,000	314,000	564,000

Month.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Mean for 30 Years, 1875 to 1904, inclusive.
January,	1,638,000	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,217,000
February,	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	1,861,000
March,	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,986,000
April,	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	2,116,000
May,	1,346,000	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	1,141,000
June,	580,000	66,000	316,000	753,000	308,000	1,987,000	419,000	592,000
July,	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	193,000
August,	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	291,000
September,	369,000	94,000	65,000	305,000	178,000	130,000	397,000	238,000
October,	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	506,000
November,	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	868,000
December,	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	1,082,000
Av. for whole year,	1,450,000	978,000	1,082,000	1,342,000	1,140,000	1,190,000	981,000	1,081,000
Av. for driest six months,	777,000	93,000	194,000	445,000	271,000	386,000	228,000	435,000

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1904.

Experiments upon the Purification of Sewage and Water at the Lawrence Experiment Station.*

By H. W. Clark, *Chemist of the Board.*

In the following report upon sewage purification the usual discussions in regard to the operation of the various sewage filters studied during the year are presented. Besides these discussions and the tables, showing the results of operation of these filters, various special studies made during the year are also described. These special studies have been as follows: —

1. Studies of the storage of nitrogen in and its removal from Filters Nos. 1 to 10, inclusive, together with details in regard to changes in management of these filters during the year to cause a reduction of stored nitrogen. Data are presented to show the results of these changes in removing nitrogen and also in improving the degree of purification of the applied sewage.

2. A comprehensive summary of the nitrogen-disposal efficiency of all the principal sand filters that have been operated at the station has been prepared, and tables showing this work are presented. These tables show the amount of nitrogen applied to these filters, the amount oxidized, the amount of unoxidized nitrogen appearing in the various effluents, the amount of nitrogen stored in the filters or unaccounted for, etc.

3. In connection with this study of the nitrogen stored and oxidized during the filtration of sewage, various special filters have been operated at the station during the year to learn as much as possible in regard to the removal, without interrupting filtration, of accumulated organic matter. In this study much has been learned in regard to the different nature of the organic matter stored in filters, the ease with which some of this matter is oxidized and nitrified, and the difficulty with which the remainder is oxidized

* The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with the writer in direct charge. Mr. Stephen DeM. Gage and Mr. George O. Adams are the principal assistants of the writer at the station, and have aided in the preparation of this report. A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the purification of sewage and water, 1890. A similar account of the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports.

or removed by bacterial action. Some interesting figures are also presented showing, by means of ignition of the sand from the filters, the total amount of organic matter stored in Filters Nos. 1, 6 and 9A.

5. Studies of the different amounts of nitrogen lost in the operation of sewage filters of different kinds, — intermittent sand filters, contact filters and intermittent continuous or sprinkling filters; that is, a comparison of the amount of nitrogen applied to these filters with that appearing in their effluents.

6. A review of prolonged studies of the groups of bacteria found in Lawrence sewage and in the filters, and the influence of these various groups on the work of the filters, that is, upon the storage, oxidation, loss of and fixation of nitrogen. In connection with this, tables are presented showing by means of tests for B. coli the relative bacterial efficiency of the various kinds of filters.

7. Studies of the comparative value of Kjeldahl and albuminoid ammonia determinations of nitrogen in the examination of sewage and the effluents of sewage filters.

8. Studies of methods of making measurements by means of a new turbidity standard of the matter in suspension in and settling out from the effluents of sewage filters.

9. Studies of the rapidity of passage of sewage through intermittent-continuous or sprinkling filters, with ensuing purification.

10. Studies of septic tanks, etc.

Analyses of Sewage.

The sewage used at the station comes through a 2½-inch pipe about 4,400 feet long. The matters in suspension in the sewage are well disintegrated by passage through this pipe. As received at the station it is a strong domestic sewage. The following tables present the result of the usual analyses of the various samples of sewage collected during the year: "Lawrence Street sewage" being the average of samples collected weekly from the sewer from which sewage is pumped to the station; "Regular station sewage" being the average of samples collected at the experiment station on at least four days of each week; "Sewage applied to Filters Nos. 1, 6 and 9A" being the average of samples collected from all sewage applied to these filters; and "Average sewage" being the average of all sewage pumped on each Tuesday of the year. Determinations of the total nitrogen and the nitrogen in solution have been made by the Kjeldahl method during the year in all of these samples with the exception of those collected from the sewage applied to Filters Nos. 1, 6 and 9A; in these the total nitrogen only was determined.

Lawrence Street Sewage.

[Parts per 100,000.]

1904.	Temperature (Deg. F.).	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen. Total.	Kjeldahl Nitrogen. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	52	2.14	0.80	.54	3.10	1.99	9.82	.081	.0058	8.30	1,420,000
February,	51	2.60	1.05	.61	3.91	2.96	12.00	.124	.0068	9.04	2,025,000
March,	46	2.68	1.43	.82	3.61	1.77	8.36	.093	.0074	8.15	1,640,000
April,	50	2.23	0.91	.61	2.72	1.25	9.24	.103	.0065	6.84	3,158,000
May,	58	2.75	1.34	.54	3.28	1.62	13.40	.150	.0440	8.95	1,800,000
June,	65	1.95	0.80	.40	2.33	1.41	14.92	.174	.0110	7.91	1,085,000
July,	73	1.95	0.78	.46	2.29	1.59	14.10	.113	.0105	6.51	1,953,000
August,	74	2.16	0.93	.56	2.34	1.44	14.37	.111	.0143	8.99	4,310,000
September,	70	2.30	0.88	.55	2.34	1.65	9.82	.189	.0112	8.90	3,126,000
October,	66	2.78	0.99	.59	3.36	2.12	12.21	.093	.0113	9.24	2,518,000
November,	61	2.49	0.93	.58	2.59	2.03	9.89	.079	.0103	10.82	1,123,000
December,	58	3.25	1.09	.67	3.21	2.31	11.37	.088	.0117	14.45	2,223,000
Average,	60	2.44	0.99	.58	2.92	1.85	11.63	.117	.0126	9.01	2,194,000

Regular Station Sewage.

[Parts per 100,000.]

1904.	Temperature (Deg. F.).	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen. Total.	Kjeldahl Nitrogen. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	53	4.61	–	–	1.48	0.79	9.50	4.59	2,226,600
February,	49	4.79	–	–	1.77	0.91	8.27	5.11	1,772,000
March,	50	4.79	–	–	1.67	0.81	10.47	5.48	1,793,000
April,	51	5.59	–	–	1.79	0.89	10.27	4.75	2,105,000
May,	59	5.02	–	–	1.44	0.64	13.90	3.84	1,566,000
June,	65	4.89	–	–	1.37	0.57	14.93	4.37	1,503,000
July,	72	4.48	0.75	.35	1.21	0.54	15.44	4.24	1,248,800
August,	71	4.61	0.76	.34	1.33	0.55	16.39	4.49	1,438,300
September,	65	4.16	0.74	.35	1.22	0.54	11.74	3.98	1,360,700
October,	58	5.77	1.03	.49	2.06	0.94	14.15	5.37	2,476,000
November,	53	7.18	1.19	.58	2.73	1.20	13.07	5.56	3,022,000
December,	45	5.88	1.23	.71	3.92	2.06	9.59	6.54	2,616,000
Average,	58	5.15	0.95	.47	1.83	0.87	12.31	4.86	1,927,300

Sewage applied to Filters Nos. 1, 6 and 9A.

[Parts per 100,000.]

1904.	Temperature (Deg. F.).	Ammonia. Free.	Ammonia. Total Albuminoid.	Kjeldahl Nitrogen.	Chlorine.	Oxygen Consumed.
January,	56	5.80	0.64	1.57	10.13	5.70
February,	59	4.87	1.08	1.79	9.12	6.23
March,	52	5.20	0.95	2.50	8.46	6.23
April,	54	5.42	0.81	1.82	11.78	5.60
May,	59	4.73	0.69	1.37	15.94	4.19
June,	65	4.88	0.70	1.26	17.26	4.41
July,	72	3.86	0.62	1.24	14.15	4.32
August,	71	3.83	0.63	1.26	16.02	3.99
September,	66	3.75	0.60	1.15	13.81	4.00
October,	60	5.13	0.79	1.76	13.77	5.19
November,	55	3.95	0.62	1.59	8.55	5.29
December,	58	3.07	0.55	1.54	5.74	4.45
Average,	61	4.54	0.72	1.57	12.06	4.97

Average Sewage.

[Parts per 100,000.]

1904.	Temperature (Deg. F.).	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen. Total.	Kjeldahl Nitrogen. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	57	4.90	-	-	1.59	0.80	10.20	4.95	2,753,000
February,	52	5.27	-	-	1.86	0.70	9.02	6.03	2,260,000
March,	52	4.38	-	-	1.62	0.89	11.40	5.64	2,270,000
April,	53	5.77	-	-	1.71	1.34	11.31	5.33	2,167,000
May,	60	5.06	-	-	1.53	0.68	14.20	4.19	2,016,000
June,	66	4.98	-	-	1.39	0.50	13.14	4.19	1,750,000
July,	73	4.78	0.80	.34	1.61	0.62	14.34	4.52	1,563,000
August,	71	4.08	0.66	.32	1.37	0.51	14.31	4.55	1,298,000
September,	67	3.97	0.79	.38	1.32	0.50	11.89	4.32	1,323,000
October,	62	6.60	1.28	.61	2.40	1.07	12.52	5.44	3,585,000
November,	53	6.76	1.28	.54	2.90	1.14	13.66	5.92	2,900,000
December,	45	4.90	0.87	.52	2.94	1.71	8.58	6.26	2,475,000
Average,	59	5.12	0.95	.45	1.85	0.87	12.05	5.11	2,197,000

NITROGEN STUDIES.

Storage of Nitrogen in and Removal from Filters Nos. 1, 2, 4, 6, 9A, 10, and Special Experiments bearing upon the Operation of these Filters.

Sand filtration is and for many years must remain the most important method of sewage purification in use in Massachusetts. Much attention is being given to the operation of the large sand filters at the experiment station, and studies are being made of everything affecting the permanency of these filters. From 1893 until the present time the filters have been so operated that it has not been necessary for purposes of sewage disposal to remove any sand from their upper layers, although considerable was removed during 1892 and 1893, after they had been in operation for five or six years. Notwithstanding the fact, however, that the surface sand during the years following 1893 has not become clogged to such an extent as to make its removal necessary in order that sewage may readily pass into the filters, enough organic matter has accumulated to gradually cause greater compactness, and because of this a more solid freezing of the upper 6 or 8 inches in depth of the sand in cold winter weather occurs than during the earlier years. The work of the filters in summer has been satisfactory, and good purification of the applied sewage has ensued, but during recent winters low nitrification and comparatively high free and albuminoid ammonia in the effluents have been the rule.

Special pains were taken to improve their work by breaking this com pact layer in the fall of 1903 and so arranging the surface of Filters Nos. 1, 6 and 9A that the sewage, instead of being applied to the whole surface, was applied to a low area; that is to say, approximately 3 inches in depth of surface sand were removed from about two-thirds of the area of each of these filters and piled up on the remaining one-third of the area. On account of this arrangement of the surface, less ice formed upon the filters, frost entered less deeply, as shown by various examinations, and somewhat better nitrification was obtained than during several previous winters. The effluents, however, were not comparable in organic purity with the effluents obtained during earlier winters, when the filters had been in operation for a much shorter period and were receiving also much weaker sewage. Early in the spring of 1904, Filters Nos. 1, 6 and 9A were ridged and trenched, these trenches being about 10 inches deep. In Filters Nos. 2 and 4 — which for many years have contained trenches filled with coarse sand to which the sewage is applied — new trenches were dug, which were filled with clean, coarse sand. The old trenches of clogged and dirty sand were allowed to remain, but since the construction of the new trenches they have not had sewage applied to them.

The object of this surface arrangement was two-fold: (1) improved winter purification of sewage, and (2) to allow the disuse or resting of large portions of the upper sand in each filter in order that the organic

matter stored upon this sand might be removed by bacterial oxidation. During the year frequent analyses have been made of the sand in order to learn if the nitrogen in the sand of the ridges was becoming less, and also to show the increase, if any, of nitrogen in the main body of the filter. As a result of this it has been learned that a portion of the stored organic matter in each filter is easily oxidized and nitrified under favorable conditions, but that there is a certain considerable percentage of more stable nitrogenous organic matter, which is very slowly acted upon by bacterial forces. From June 4 to September 1, the nitrogen in the sand of the ridges in Filter No. 1 decreased as follows, as shown by the analyses of samples collected : —

Decrease of Nitrogen in Sand of Filter No. 1.

[Parts per 100,000.]

Ridge No.	Albuminoid Ammonia.		Ridge No.	Albuminoid Ammonia.	
	June 4.	Sept. 1.		June 4.	Sept. 1.
1, ...	64.0	41.0	3, ...	87.0	51.0
2, ...	71.7	44.2	4, ...	75.0	48.0

Averaging these results we find that the albuminoid ammonia in the sand of the ridges decreased during these three months from an average of 74.4 parts to an average of 46.05 parts per 100,000, a decrease of 38 per cent. At the end of November, three months later, the average amount of nitrogen determined as albuminoid ammonia in the sand of ridges was 45.9 parts, that is, almost exactly the same as at the beginning of September, although the warm month of September and the comparatively warm months of October and November were favorable to bacterial action, and during these months the effluents of these filters were high in nitrates.

Decrease of Nitrogen in Filters Nos. 6, 9A and 10.

The ridges of Filter No. 6 contained, on June 8, 118.5 parts of albuminoid ammonia ; on August 8, 65.2 parts, a decrease of 45 per cent. ; and on November 18, an average of 67.8 parts, an apparent slight increase above that found on August 8, but this apparent increase was undoubtedly due to sampling and to the uneven distribution of nitrogen in the sand. The ridges of Filter No. 9A contained, on June 8, 62 parts albuminoid ammonia ; on August 8, 55 parts, a decrease of 10 per cent. only ; and an examination on November 15 showed no further decrease.

On June 3, 1904, 8 inches in depth of surface sand from Filter No. 10 were removed and piled in a thin layer by the side of the filter, analyses being made from time to time, dates of examination and results of these analyses being as follows, and showing a decrease of the nitrogen determined as albuminoid ammonia of about 50 per cent. in four months : —

Decrease of Nitrogen in Sand of Filter No. 10.

[Parts per 100,000.]

	Albuminoid Ammonia.		Albuminoid Ammonia.
June 3,	195.0	August 17,	114.0
June 15,	104.0	August 29,	114.0
July 20,	109.0	October 12,	96.0

Sub-surface Nitrogen.

The following table gives the amount of nitrogen determined as albuminoid ammonia found at different depths below the surface ridges in Filter No. 1 upon Nov. 23, 1903, and Oct. 10, 1904: —

Determinations of Nitrogen in Sand of Filter No. 1.

[Parts per 100,000.]

Depth.	Albuminoid Ammonia.		Depth.	Albuminoid Ammonia.	
	Nov. 23, 1903.	Oct. 10, 1904.		Nov. 23, 1903.	Oct. 10, 1904.
6 inches,	46.3	47.0	24 inches,	7.2	9.2
9 inches,	58.5	45.1	36 inches,	4.9	6.3
12 inches,	18.2	39.0	48 inches,	3.3	5.0
15 inches,	13.6	14.0	60 inches,	4.6	3.4
18 inches,	16.8	11.9			

Studying this table it will be seen that there was only a slight increase of stored nitrogen during the year 1904 in the main body of this filter. A similar table, showing the amount of nitrogen stored below the surface ridges in Filter No. 9A, Nov. 30, 1903, and Oct. 12, 1904, follows: —

Determinations of Nitrogen in Sand of Filter No. 9A.

[Parts per 100,000.]

Depth.	Albuminoid Ammonia.		Depth.	Albuminoid Ammonia.	
	Nov. 30, 1903.	Oct. 12, 1904.		Nov. 30, 1903.	Oct. 12, 1904.
6 inches,	50.0	59.4	24 inches,	6.2	6.5
9 inches,	39.5	52.8	36 inches,	3.9	6.0
12 inches,	11.5	47.6	48 inches,	3.6	4.7
15 inches,	8.9	29.7	60 inches,	3.1	4.1
18 inches,	6.7	15.5			

These figures show a considerable increase in the nitrogen stored in the filter towards the end of 1904 above that stored towards the end of 1903; but analyses of samples from the different depths in previous years have shown a considerable fluctuation in the amount of nitrogen present at these depths from season to season and from year to year.

Special Studies upon Nitrification and Removal of Nitrogen by Means of Filters constructed of Surface Sand from Filters Nos. 1, 6 and 9A, etc.

During the year five small filters, Nos. 265, 266, 267, 268 and 269, respectively, have been operated for further study of the removal of organic matter from clogged sand. These filters were placed in the laboratory and were started early in May. Each contained 1 foot in depth of sand. Filter No. 265 was constructed of surface sand from Filter No. 1, Filter No. 266 of surface sand from Filter No. 6, Filter No. 267 of surface sand from Filter No. 9A, Filter No. 268 of surface sand from the sewage disposal area at Clinton, Mass., and Filter No. 269 was constructed of fresh clean sand. Each of these filters was flooded with water, and the rate of operation of each was 30,000 gallons per acre daily. The sand in Filter No. 265 contained at the beginning of the experiment 144.7 parts of albuminoid ammonia; the sand in Filter No. 266, 118.5 parts of albuminoid ammonia; the sand in Filter No. 267, 59.3 parts albuminoid ammonia; and the sand in Filter No. 268, 61.3 parts albuminoid ammonia per 100,000. Tables showing the results of analyses of effluents of these filters are given below.

Nitrification started immediately in Filter No. 265, containing sand from Filter No. 1, and at the end of a week of operation the effluent of this filter contained 15 parts of nitrates per 100,000. In Filter No. 266 nitrification also started immediately, but was not so intense as in Filter No. 265. However, at the end of a week the effluent of this filter contained over 5 parts of nitrates per 100,000. In Filter No. 267, containing the finer sand from Filter No. 9A, nitrification did not become particularly active until a month had elapsed, when its effluent contained 3.5 parts of nitrates per 100,000, this being the maximum amount reached during the operation of this filter. Filter No. 268, constructed of sand from the Clinton area, was very irregular in its action, nitrification beginning immediately, but changing quickly from high to low nitrification and *vice versa*. Results similar to these are obtained at the Clinton area.

The particularly noticeable fact learned by the operation of these filters was that, from each sand, a large amount of the stored nitrogenous organic matter was removed at the end of two months of operation, but at the end of seven months but little further removal had occurred; that is to say, — as shown also by the experiment in ridging and trenching Filters Nos. 1, 6 and 9A, — much of the stored organic matter was easily oxidized, but there was a residual amount of stable organic matter stored upon the sand

that was very slowly changed by bacterial action. During the entire period of operation, even after nitrogen removal had practically ceased, some nitrification was occurring in the filters, and conditions were favorable for nitrogen removal, as the filters, being in the laboratory, were always warm.

The reduction of nitrogen in the sand of Filter No. 265 in two months, as shown by albuminoid ammonia determinations, was from 144.7 to 42.7 parts per 100,000 of albuminoid ammonia, or 70.5 per cent.; but at the end of four months and eight months the amount found in the sand was still 42 and 43 parts, respectively, although throughout this latter period nitrates averaging 0.5 part per 100,000 were found in the effluent of this filter, as shown in a following table.

Practically the same results were given by Filters Nos. 266, 267 and 268. A reduction in albuminoid ammonia in the sand in Filter No. 266 from 118.5 to 53 parts per 100,000, or 55 per cent., occurred in two months, and at the end of eight months of operation there were still 53 parts of albuminoid ammonia present in this sand, although the effluent had continued to contain nitrates in considerable amounts. Filter No. 267 showed a reduction from 59 to 41 parts per 100,000, or 30 per cent., in two months, and at the end of eight months no further decrease had occurred. Filter No. 268 showed a reduction from 61 parts to 43 parts per 100,000, or 30 per cent., at the end of two months, and at the end of four and eight months 43 and 35 parts of albuminoid ammonia per 100,000 were found, respectively.

The following tables show the actual amount of nitrogen removed from the sand of each filter, as shown by analyses of the sand, and found present in the effluents, as shown by analyses of these effluents, as free ammonia, nitrates and nitrites. It will be seen that the amount found in the effluent of Filter No. 265 was only about 18 per cent. of the total amount removed; with Filter No. 266 the amount of nitrogen accounted for in this way was 23 per cent. of the total amount removed, and with Filter No. 267, 71 per cent., these results showing that much nitrogen escaped into the air as the result of the work of nitrogen-liberating bacteria undoubtedly present in large numbers in each filter.

Tables showing the Amount of Nitrogen in the Sand of Filters Nos. 265, 266, 267 and 268 at Different Periods and the Amount of Nitrogen appearing in the Effluents.

Total Nitrogen, in Grams, in the Sand of Filters Nos. 265, 266, 267 and 268 at Different Periods of Operation.

1904-1905.	Filter No. 265.	Filter No. 266.	Filter No. 267.	Filter No. 268.
Beginning of operation,	1.780	1.080	.576	.662
July 26,	0.525	0.480	.402	.460
August 29,	0.518	0.432	.415	.464
December 15,	0.527	0.482	.449	.378
March 1,	0.521	0.407	-	.362

Tables showing the Amount of Nitrogen in the Sand of Filters Nos. 265, 266, 267 and 268 at Different Periods and the Amount of Nitrogen appearing in the Effluents — Concluded.

Amount of Nitrogen, in Grams, removed from Filters Nos. 265, 266, 267 and 268, and appearing in their Effluents as Free Ammonia, Nitrates and Nitrites.

1904-1905.	Filter No. 265.	Filter No. 266.	Filter No. 267.	Filter No. 268.
May,	.055	.012	.062	.006
June,	.082	.045	.023	.019
July,	.088	.035	.023	.014
August,	.017	.017	.004	.008
September,	.012	.011	.002	.005
October,	.009	.006	.002	.004
November,	.009	.005	.002	.004
December,	.007	.004	.003	.003
January,	.005	.003	.003	.003
Total,	.234	.138	.124	.061

Various efforts were made, after removal of nitrogen had practically ceased, to cause a more rapid oxidation of the stable organic matter in these filters, that is, to increase nitrification. Lime, potassium carbonate, sodium chloride, hydrochloric acid in minute amounts, etc., were experimented with and added to the sewage at different times in order to cause, if possible, increased activity of the nitrifying organisms, but these efforts were not successful. River water was also used in order to be sure that the nitrifying organism was passed to each filter, and finally river water containing 1 per cent. of sewage. Cultures of bacteria were also introduced. All this was without effect, however, and while nitrification remained comparatively uniform in several of these filters, it was low, notwithstanding the large amount of organic matter remaining upon the sand.*

Conclusions.

All this work upon the removal of organic matter has clearly shown that by systematic resting of large amounts of the upper sand of sewage filters a considerable percentage of the nitrogenous organic matter can be removed by bacterial means, especially when the filters have been in use for many years and the organic matter accumulated upon this sand has undergone long-continued bacterial working over; but it has also clearly shown the stable nature of a large percentage of this organic matter. Undoubtedly, however, a portion of the stable organic matter now present on the sand will, in the course of time, become of a nature as easily oxidized as that shown to be readily oxidized during the past year, but a portion is probably as stable as humus. In other words it is stable as soil

* During 1905 it has been proved that if easily nitrified but sterile nitrogen is added to these filters, nitrification will become active within them, but practically ceases again when this easily nitrified nitrogen is exhausted. This will be discussed in a future report.

nitrogen which remains year after year at practically the same point unless exhausted by severe cropping. It is part of the residual organic matter remaining after that easily changed has been removed by bacterial action. With the constant accumulation, caused by regular application of sewage, it will be difficult to lessen the actual amount of this residual matter present in the entire body of the filter; that is to say, while ridging will allow the resting of a portion of the sand, this ridging renders it necessary to apply the sewage to lower depths of the filter, and the consequent more rapid accumulation of organic matter at these depths than would otherwise occur.

Tables of Analyses of Effluents of Filters Nos. 265, 266, 267, 268 and 269.

Filter No. 265.

Constructed of 1 foot of sand from the surface of Filter No. 1. Flooded daily with water at the rate of 30,000 gallons per acre daily. Effluent clear. The albuminoid ammonia of this sand at the start was 144.7 parts per 100,000 parts, and after being flooded sixty times was 42.7 parts.

Average Analyses.

[Parts per 100,000.]

1904.	Free Ammonia.	Nitrogen as		Alkalinity by	
		Nitrates.	Nitrites.	Methyl-Orange.	Gallein.
May 20,	1.2500	5.89	.1000	-	-
May 21,	1.1750	1.40	.0300	-	-
May 23,	1.9000	5.40	.0600	-	-
May 24,	1.6000	8.32	.0800	-	-
May 26,	0.7500	12.18	.0150	-	-
May 28,	0.1300	15.10	.0040	-	-
May 31,	0.0600	15.53	.0240	1.0	-
June,	0.0500	5.93	.0030	0.5	-
July,	0.0150	2.75	.0018	—0.6	—0.7
August,	0.0100	1.17	.0000	—0.7	—0.2
September,	0.0275	0.71	.0002	0.4	0.4
October,	0.0480	0.63	.0004	0.5	0.5
November,	0.0860	0.65	.0002	0.3	0.3
December,	0.0250	0.45	.0010	0.3	0.3

October 27, mixed water cultures of bacteria with ammonifying, denitrifying and nitrogen liberating power applied. Beginning December 16 filter flooded with river water.

Filter No. 266.

Constructed of 1 foot of sand from the surface of Filter No. 6. Flooded daily with water at the rate of 30,000 gallons per acre daily. Effluent clear. The albuminoid ammonia of this sand at the start was 118.5 parts per 100,000 parts. Albuminoid ammonia after being flooded sixty times was 52.8 parts.

Average Analyses.

[Parts per 100,000.]

1904.	Free Ammonia.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Alkalinity by Methyl-Orange.	Alkalinity by Gallein.
May 20,	.9500	0.63	.0900	-	-
May 21,	.9400	1.40	.0800	-	-
May 23,	.1800	2.25	.0200	-	-
May 24,	.2600	1.82	.0300	-	-
May 26,	.1500	1.68	.0000	-	-
May 28,	.0600	5.05	.0020	-	-
May 31,	.0800	1.26	.0020	0.7	-
June,	.0567	3.19	.0000	—0.4	-
July,	.0675	2.50	.0018	—0.7	—0.4
August,	.0200	1.21	.0002	—0.5	—0.4
September,	.0225	0.77	.0000	0.3	0.3
October,	.0333	0.42	.0005	0.8	0.8
November,	.0180	0.35	.0006	0.5	0.5
December,	.0300	0.27	.0025	0.6	0.6

Beginning Oct. 27, 1904, Filter No. 266 flooded with solution of 5 parts chlorine as sodium chloride. December 7 discontinued flooding filter with sodium chloride. Began flooding with distilled water. Beginning December 16 filter flooded with river water.

Filter No. 267.

Constructed of 1 foot of sand from the surface of Filter No. 9A. Flooded daily with water at a rate of 30,000 gallons per acre daily. Effluent was turbid and colored with iron until June 7, when it became clear. The albuminoid ammonia of this sand at the start was 59.3 parts per 100,000 parts, and after being flooded sixty times was 41.3 parts.

Average Analyses.

[Parts per 100,000.]

1904.	Free Ammonia.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Alkalinity by Methyl-Orange.	Alkalinity by Gallein.
May,	5.2000	0.21	.0300	14.8	-
June,	0.4475	1.29	.0193	3.8	-
July,	0.0500	1.65	.0010	—3.1	—2.0
August,	0.0760	0.20	.0002	1.0	0.8
September,	0.0263	0.14	.0000	2.1	1.9
October,	0.0283	0.10	.0007	2.0	1.9
November,	0.0180	0.14	.0004	1.7	1.7
December,	0.0300	0.18	.0005	1.0	1.0

Beginning Oct. 27, 1904, Filter No. 267 flooded with a solution of 4.4 parts potassium carbonate. December 7 discontinued flooding filter with potassium carbonate solution and began flooding with distilled water. Beginning December 16 filter flooded with river water.

Filter No. 268.

Constructed of 1 foot of sand from the Clinton sewage-disposal area. Flooded with water at rate of 30,000 gallons per acre daily. Effluent clear. The albuminoid ammonia of this sand at the start was 61.33 parts per 100,000 parts, and after being flooded fifty-three times was 42.70 parts.

Average Analyses.

[Parts per 100,000.]

1904.	Free Ammonia.	Nitrogen as		Alkalinity by	
		Nitrates.	Nitrites.	Methyl-Orange.	Gallein.
May,	.0967	5.14	.0087	0.4	-
June,	.0600	1.31	.0010	1.1	-
July,	.0325	1.02	.0025	1.6	1.2
August,	.0200	0.22	.0022	1.3	0.7
September,	.0213	0.37	.0008	1.7	1.6
October,	.0400	0.24	.0013	1.0	0.9
November,	.0420	0.24	.0010	0.5	0.5
December,	.0350	0.22	.0005	0.8	0.7

Beginning Oct. 27, 1904, Filter No. 268 flooded with a solution of 1.2 parts hydrochloric acid. December 7 discontinued flooding with hydrochloric acid solution and began flooding with distilled water. Beginning December 16 filter flooded with river water.

Filter No. 269.

Constructed of 1 foot of clean sand. Flooded with regular sewage at rate of 30,000 gallons per acre daily.

Average Analyses.

[Parts per 100,000.]

1904.	Free Ammonia.	Nitrogen as		Alkalinity by	
		Nitrates.	Nitrites.	Methyl-Orange.	Gallein.
July,	0.5350	3.09	.0775	-	-
August,	0.2680	2.63	.1574	3.1	2.7
September,	0.3650	2.56	.0173	1.0	0.8
October,	1.5933	2.93	.0050	1.4	1.4
November,	2.7367	2.50	.0153	2.0	1.9
December,	1.8250	7.47	.0150	0.1	—0.5

A Study of the Work accomplished by Sand Filters in the Disposal of Nitrogen, including Figures showing Nitrogen applied, Nitrogen oxidized, Nitrogen not appearing in the Effluent, Nitrogen stored in the Sand, etc.

In the purification of sewage by sand filtration good nitrification must ensue if a purified effluent is to be obtained and the filters be reasonably permanent, that is, suitable to accomplish good work year after year. This is especially so if the filters are operated in a manner similar to that followed at the experiment station, as at the station no solid matter strained out from the sewage by the filter is removed from the surface of the filter; and, in fact, with sewage of the character of that at the station, practically all matters pass below the surface of the sand. At many of the filtration areas in the State, however, which receive fresh sewage containing much organic matter only slightly disintegrated, a large amount of material strains out upon and is removed from the surface of the filter beds or is settled out and passed to sludge beds; and this removal lessens the work that must be accomplished by the filter itself, as a smaller amount of organic matter has to be oxidized or nitrified within the body of the filter. The Lawrence Experiment Station sewage contains as much suspended organic matter as most of the sewages of the towns and cities of the State having filtration areas, but as this matter is very finely divided and largely passes into the upper layers of sand in the filters, nitrification must average much greater than at the municipal areas. A comparison of the per cent. of oxidized nitrogen present in the effluents of the Lawrence filters and in the effluents of the municipal filters shows the truth of this statement. (For tables see pages 212 to 216, inclusive, and page 224.)

A study of the percentage of the actual amount of nitrogen applied to Lawrence sand filters that appears in their effluents (1) in an oxidized condition, (2) in an unoxidized condition and (3) of the percentage of the applied nitrogen removed by the filter, etc., has been made, and the results obtained are given in following tables. It is evident from this study that the average amount of the applied nitrogen that is nitrified while the sewage is passing through the Lawrence filters is between 50 and 55 per cent. These tables also show clearly that when the sand filters at Lawrence were first put into operation the percentage of nitrogen nitrified in the filter was generally much smaller than when the filter had been better seeded with nitrifying organisms. During the first year or two of operation, also, a very much larger percentage of the applied nitrogen was stored in the filter than during subsequent years, and hence a smaller percentage of unoxidized nitrogen appeared in the effluents of these filters than during subsequent years. For example, Filter No. 1, during its first year of operation, as shown in a following table, stored or otherwise removed from the applied sewage 63 per cent. of its nitrogen, that is to say, only 37 per cent. of the nitrogen applied appeared oxidized and unoxidized

in the filter effluent. With Filter No. 2, 68 per cent. of the nitrogen applied during the first year of operation and 58 per cent. of the nitrogen applied during the second year of operation did not appear in the effluent of the filter. With Filter No. 4, 81 per cent. of the nitrogen applied during the first year and 75 per cent. of that applied during the second year did not appear in the effluent of the filter. With Filter No. 6, 70 per cent. of the nitrogen applied during the first year did not appear in the filter effluent, and with Filter No. 9A, 75 per cent. of the nitrogen applied during the first year did not appear in its effluent. Taking, however, the entire series of years of operation of these filters up to the end of 1904, the average amount of the applied nitrogen not appearing in the effluents has been 28 per cent. for Filter No. 1, 35 per cent. for Filter No. 2, 46 per cent. for Filter No. 4, 34 per cent. for Filter No. 6, and 29 per cent. for Filter No. 9A.

During the first years of operation of these filters the average percentage of the applied nitrogen that appeared as nitrates in the effluents was considerably less than during subsequent years, as shown by the tables. For instance, during the first full calendar year of operation of Filter No. 2 the percentage of the applied nitrogen appearing as nitrates in its effluent was 41, although the average for the entire period of operation up to the end of 1904 has been nearly 53. The nitrates for the first full year of operation of Filter No. 4 contained 23.6 per cent. of the applied nitrogen, while the average for the entire period up to date is 48 per cent., and similar figures are shown by the other sand filters studied.

As the filters became older, that is, as they were continued in use year after year, the percentage of applied nitrogen appearing as nitrates increased. In different years from 65 to 77 per cent. of the applied nitrogen appeared as nitrates in the filter effluent, high nitrification following the rejuvenating of Filters Nos. 1, 6 and 9A in 1893, the year when clogged surface sand was last removed. Notwithstanding this increase in nitrification, however, there was a considerable increase year after year in the amount of unoxidized nitrogen appearing in the effluents, this fact being probably in a large measure accounted for by the increased strength of the sewage, that is, a larger amount of nitrogen was applied to the filters each year. In each of the tables following, giving the nitrogen results of this study of the various filters, are columns showing the average nitrogen in parts per 100,000 in the applied sewage, and also the "units" of applied nitrogen, the "units" being obtained by multiplying the average parts of nitrogen per 100,000 in the applied sewage by the rate of operation of each filter in thousand gallons per acre daily.

Summarizing this work the following conclusions can be drawn: —

1. With new sand filters a smaller percentage of the applied nitrogen appears in the effluent than when the filters have been operated for a considerable period.

2. With filters producing eminently satisfactory purification, as Filters Nos. 2 and 4, during many of the years included in the table, the average amount of nitrogen appearing in the effluents as nitrates is but little more than 50 per cent. of the nitrogen in the applied sewage.

3. This being so, it is clear that, if a filter is not ultimately clogged by stored nitrogenous organic matter, either removal of this matter must be resorted to, together with a removal of some of the filtering material, or a removal by bacterial actions independent of and differing from those of nitrification must be depended upon.

4. Much of the increase of unoxidized nitrogen in the effluent of the sand filters has been due to the increase of applied nitrogen year by year and the accumulation of stable organic matter in the filter.

On account of the application of this larger amount of nitrogen two results ensue: (1) an amount of nitrogen in solution greater than can be easily and completely changed by bacterial action during the period of passage of the sewage through the filter, and (2) an amount of stable organic matter in suspension in the sewage is strained out and, accumulating in the upper sand of each filter, causes unfavorable conditions, especially in winter, on account of the resultant increased compactness of these upper layers.

Differing bacterial flora in the filter due to increase in stored organic matter and continued use of the filter may also be an important factor.

FILTER NO. 1. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Sewage for Filter No. 1."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
					IN EFFLUENT.	
		Parts per 100,000.	Units.	Not appearing in Effluent.	Oxidized.	Un-oxidized.
1888,*	53.4	2.70	144	63.0	29.6	7.4
1889,	63.6	2.71	172	40.9	55.4	3.7
1890,	84.2	2.92	246	47.0	46.5	6.5
1891,	115.8	3.32	383	51.1	39.6	9.3
1892,	124.1	3.78	469	48.2	40.7	11.1
1893,	105.9	3.66	389	23.3	58.7	18.0
1894,	70.3	4.47	314	17.0	71.1	11.9
1895,	67.4	4.06	274	9.4	68.5	22.1
1896,	56.8	4.81	273	28.6	63.1	8.3
1897,	62.1	4.95	308	33.1	55.0	11.9
1898,	60.5	4.29	259	27.8	62.0	10.2
1899,	54.8	4.32	237	27.1	59.5	13.4
1900,	51.9	4.95	257	31.7	55.3	13.0
1901,	57.2	5.40	309	24.8	34.8	40.4
1902,	56.6	4.95	280	18.6	45.0	36.4
1903,	72.0	4.84	349	8.7	58.1	33.2
1904,	54.9	6.11	336	21.2	54.6	24.2
Average,	71.3	4.25	303	28.5	53.4	18.1

* Filter started Jan. 10, 1888.

FILTER NO. 2.— *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Sewage for Filter No. 1."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT.	
					Oxidized.	Un-oxidized.
1888,*	28.2	2.70	76	68.5	25.2	6.3
1889, ...	32.0	2.71	87	58.3	40.6	1.1
1890, ...	59.6	2.92	174	43.2	55.8	1.0
1891, ...	50.8	3.32	169	59.0	31.8	9.2
1892, ...	24.5	3.78	93	47.9	38.4	13.7
1893, ...	40.3	3.66	147	24.9	67.5	7.6
1894, ...	43.9	4.47	196	33.0	63.9	3.1
1895, ...	33.7	4.06	137	21.0	66.0	13.0
1896, ...	37.0	4.81	178	25.0	68.1	6.9
1897, ...	37.0	4.95	183	46.5	49.3	4.2
1898, ...	38.3	4.29	164	41.8	53.8	4.4
1899, ...	34.4	4.32	149	40.0	51.2	8.8
1900, ...	33.8	4.95	167	25.7	67.0	7.3
1901, ...	36.3	5.40	196	33.4	44.8	21.8
1902, ...	31.2	4.95	154	18.7	53.7	27.6
1903, ...	34.7	4.84	168	9.3	66.5	24.2
1904, ...	32.6	6.11	199	35.6	38.1	26.3
Average, . . .	37.0	4.25	157	35.2	52.6	12.2

* Filter started Dec. 19, 1887.

FILTER NO. 4.— *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Average Sewage for Filters Nos. 1, 6 and 9A."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT.	
					Oxidized.	Un-oxidized.
1888,*	28.7	2.70	76	80.8	8.1	11.1
1889, ...	20.0	2.71	54	75.3	23.6	1.1
1890, ...	33.2	2.92	97	55.8	43.5	0.7
1891, ...	41.4	3.32	137	53.3	43.6	3.1
1892, ...	41.8	3.87	162	68.7	17.6	13.7
1893, ...	32.3	3.81	123	58.8	38.0	3.2
1894, ...	20.1	4.47	90	56.0	34.2	9.8
1895, ...	15.8	4.60	73	53.5	44.8	1.7
1896, ...	19.0	5.01	95	39.7	55.5	4.8
1897, ...	19.4	5.01	97	39.3	58.5	2.2
1898, ...	19.3	4.30	83	46.0	52.8	1.2
1899, ...	16.8	4.01	68	46.7	51.1	2.2
1900, ...	17.8	5.06	90	33.9	64.5	1.6
1901, ...	20.4	5.50	112	41.3	49.8	8.9
1902, ...	19.6	4.95	97	14.6	62.2	23.2
1903, ...	18.2	4.84	88	30.1	64.1	5.8
1904, ...	18.0	6.11	110	39.3	56.3	4.4
Average, . . .	23.6	4.31	102	46.4	47.8	5.8

* Filter started Dec. 19, 1887.

FILTER NO. 5A. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Average Sewage for Filters Nos. 1, 6 and 9A."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT. Oxidized.	IN EFFLUENT. Un-oxidized.
1891,*	64.0	5.15	330	76.2	17.2	6.6
1892,	94.4	3.87	366	48.1	30.2	21.7
1893,	119.2	3.81	454	32.6	48.0	19.4
1894,	90.6	4.47	405	23.7	60.6	15.7
1895,	68.3	4.60	314	23.1	54.1	22.8
1896,	56.1	5.01	281	16.3	61.9	21.8
1897,	58.8	5.01	295	26.3	54.8	18.9
1898,†	83.2	4.10	341	36.6	28.5	34.9
Average,	79.3	4.50	357	35.5	44.7	19.8

* Filter started Sept. 14, 1891. † Two months, January and February.

FILTER NO. 5B. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Average Sewage for Filters Nos. 1, 6 and 9A."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT. Oxidized.	IN EFFLUENT. Un-oxidized.
1898,*	72.8	4.08	298	40.5	42.9	16.6
1899,	81.7	4.01	327	19.2	58.8	22.0
1900,	109.2	5.06	553	25.5	56.7	17.8
1901,	131.5	5.50	722	27.0	45.0	28.0
1902,	116.9	4.95	579	18.5	58.9	22.6
1903,	90.0	4.84	435	6.3	61.0	32.7
1904,	72.6	6.11	444	22.0	53.8	24.2
Average,	96.4	4.94	476	22.7	54.0	23.7

* Filter started March 5, 1898.

FILTER NO. 6. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Average Sewage for Filter No. 6."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT.	
					Oxidized.	Un-oxidized.
1888,*	39.5	2.70	107	70.4	26.3	3.3
1889,	41.0	2.71	111	46.4	52.5	1.1
1890,	55.2	2.92	161	55.8	42.1	2.1
1891,	61.2	3.32	203	46.0	40.3	5.7
1892,	46.9	4.07	191	43.5	40.5	16.0
1893,	85.5	3.97	340	29.5	57.7	12.8
1894,	54.3	4.53	246	26.6	67.8	5.6
1895,	57.6	4.72	272	29.0	55.4	15.6
1896,	56.8	5.50	312	36.4	52.0	11.6
1897,	60.5	5.02	304	33.7	57.1	9.2
1898,	65.6	5.13	336	41.5	53.6	4.9
1899,	59.4	3.95	234	26.1	65.3	8.6
1900,	51.7	5.02	260	30.6	57.7	11.7
1901,	57.6	5.49	316	29.0	43.3	27.7
1902,	58.0	4.95	287	15.8	44.6	39.6
1903,	70.2	4.84	340	17.9	52.4	29.7
1904,	54.4	6.11	333	25.8	49.9	24.3
Average,	57.4	4.41	253	33.7	51.3	15.0

* Filter started Jan. 12, 1888.

FILTER NO. 9A. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Average Sewage for Filter No. 9A."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT.	
					Oxidized.	Un-oxidized.
1890,*	110.0	3.38	372	74.9	2.1	23.0
1891,	95.8	3.32	318	45.5	40.3	14.2
1892,	68.1	3.77	257	48.8	35.3	15.9
1893,	111.7	3.80	424	29.8	51.5	18.7
1894,	68.8	4.40	303	22.4	66.0	11.6
1895,	66.0	5.02	332	30.1	51.0	18.9
1896,	56.3	4.71	265	17.7	68.5	13.8
1897,	61.5	5.07	312	19.3	67.7	13.0
1898,	74.2	3.48	258	24.1	65.0	10.9
1899,	59.5	3.75	223	21.0	64.3	14.7
1900,	48.8	5.22	255	28.6	58.6	12.8
1901,	53.9	5.60	302	19.3	39.3	41.4
1902,	57.0	4.95	282	20.0	46.5	33.5
1903,	69.2	4.84	335	20.5	54.1	25.4
1904,	53.8	6.11	329	36.4	48.2	15.4
Average,	70.3	4.49	316	29.3	51.3	19.4

* Filter started Nov. 18, 1890.

FILTER No. 10.— *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Average Sewage for Filter No. 9A."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	Nitrogen applied.		Per Cent. of Applied Nitrogen.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	In effluent.	
					Oxidized.	Un-oxidized.
1894,*	40.0	6.17	247	48.8	45.9	5.3
1895, ...	36.7	5.02	184	38.8	48.5	12.7
1896, ...	28.2	4.71	133	27.3	65.1	7.6
1897, ...	29.5	5.07	149	30.1	60.4	9.5
1898, ...	28.6	3.48	100	14.1	77.3	8.6
1899, ...	25.0	3.75	94	19.7	68.3	12.0
1900, ...	25.5	5.22	133	30.9	62.0	7.1
1901, ...	27.8	5.60	156	28.5	47.7	23.8
1902, ...	26.4	4.95	131	30.3	52.5	17.2
1903, ...	21.7	4.84	105	30.3	56.0	13.7
1904, ...	17.2	6.11	105	40.6	45.3	14.1
Average, ...	27.9	4.99	140	32.3	55.7	12.0

* Filter started July 18, 1894.

In connection with this study of nitrogen changes the following table is of interest. It presents the average nitrates in the average yearly effluents of Filters Nos. 1, 2, 4, 6, 9A and 10 inclusive, and shows that the actual amount of nitrates present in these effluents has been a varying quantity, but greater during the past ten years than formerly, and that the nitrates for 1904 have been exceeded in only two years since the beginning of operation of these filters, namely, 1896 and 1900.

Average Nitrates, Filters Nos. 1, 2, 4, 6, 9A and 10.

[Parts per 100,000.]

Year.	Nitrates.	Year.	Nitrates.
1888, ...	0.60	1897, ...	2.89
1889, ...	1.17	1898, ...	2.48
1890, ...	1.11	1899, ...	2.39
1891, ...	1.29	1900, ...	3.06
1892, ...	1.32	1901, ...	2.36
1893, ...	2.03	1902, ...	2.51
1894, ...	2.70	1903, ...	2.83
1895, ...	2.48	1904, ...	2.98
1896, ...	3.00		

Further Nitrogen Studies.

So far, in this nitrogen work, attention has been called only to Filters Nos. 1, 2, 4, 6, 9A and 10, but in tables given beyond are many data in regard to the nitrogen applied to and oxidized by several of the other sand filters that have been operated at the station. Special studies have been made with Filters Nos. 14A, 19 and 100. Each of these filters was operated at rates much greater than those of the filters already discussed, this greater rate being followed since the sewage applied to each filter had been so treated before application that much of the matters in suspension had been removed. All the sewage applied to Filter No. 14A had previously passed through a coke strainer; all the sewage applied to Filter No. 19 after Jan. 20, 1893, had been treated with chemicals to cause precipitation, and all the sewage applied to Filter No. 100 had first passed through a septic tank. The tables show the enormous amount of unoxidized nitrogen calculated as "units" applied to these filters compared with the amount applied to Filters Nos. 1 to 10, inclusive, which received untreated sewage; the average units applied to Filter No. 14A each year being 1,005, to Filter No. 19, 599, and to Filter No. 100, 1,180, compared with averages of 303, 253 and 316, the average amount in units applied to Filters Nos. 1, 6 and 9A, respectively. As a considerable percentage of the matter in suspension in the sewage had been removed, leaving a larger percentage of the total organic matter applied in the form of the more easily oxidized organic matter in solution, the percentage of oxidation in these filters has averaged somewhat greater than in Filters Nos. 1 to 10, inclusive, the highest percentage being given by Filter No. 14A, namely, 70 per cent.

It is evident from a study of all these nitrogen data, together with daily observations of the ease or difficulty of satisfactory operation of various filters after years of work, etc., that there is a fairly well-defined limit to the amount of work that can be accomplished by a sand filter, or, in other words, a filter can care for about so much organic matter, year after year, irrespective, within reasonable limits, of the volume of sewage in which this matter is contained. The greater the percentage of the total organic matter of the sewage in solution, the greater the percentage of oxidation within the filter. Ordinarily, however, only slightly more than 50 per cent. of the applied nitrogen will appear as nitrates in the effluents of filters receiving untreated sewage, and if the remaining nitrogen and carbon are greater than the nitrogen- and carbon-liberating bacteria in the filter can adequately care for, there is an excessive accumulation of organic matter in the filter, eventually necessitating the removal of sand from the filter, prolonged resting, or cropping, which may be the most efficient and practical method. Methods already taken to cause a removal of this nitrogen without removing sand have been described in previous pages.

FILTER NO. 14A. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Strained Sewage."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT.	
					Oxidized.	Un-oxidized.
1894,*	345.1	3.43	1,180	21.6	72.6	5.8
1895,	307.1	4.74	1,452	36.4	55.1	8.5
1896,	279.9	4.29	1,200	27.8	65.0	7.2
1897,	279.7	4.28	1,197	24.5	68.0	7.5
1898,	298.0	2.88	857	12.5	83.0	4.5
Average,	302.0	3.92	1,177	24.6	68.7	6.7

* Filter started Jan. 12, 1894.

FILTER NO. 19. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Regular Sewage" and chemically treated sewage.*]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	NITROGEN APPLIED.		PER CENT. OF APPLIED NITROGEN.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	IN EFFLUENT.	
					Oxidized.	Un-oxidized.
1890,†	58.2	2.92	170	37.0	57.2	5.8
1891,	90.6	3.32	301	34.4	63.5	2.1
1892,	51.2	3.56	183	38.0	60.0	2.0
1894,	253.2	4.09	1,036	29.4	60.8	9.8
1895,	196.9	5.22	1,028	31.9	60.6	7.5
1896,	189.6	5.43	1,030	33.2	60.7	6.1
1897,	190.0	3.92	745	21.6	70.5	7.9
Average,	147.1	4.07	599	32.2	61.9	5.9
Average 1890 to 1892 inclusive,	66.7	3.27	218	36.7	60.2	3.1
Average 1894 to 1897 inclusive,	207.4	4.67	969	29.0	63.2	7.8

* Regular sewage applied until 1894, after that date sewage clarified by chemicals.
† Filter started Jan. 28, 1890.

FILTER No. 100. — *Table showing Nitrogen applied and Nitrogen Changes.*

[Sewage applied: "Septic Sewage A."]

	Volume of Sewage applied (Thousand Gallons per Acre Daily).	Nitrogen applied.		Per Cent. of Applied Nitrogen.		
		Parts per 100,000.	Units.	Not appearing in Effluent.	In Effluent.	
					Oxidized.	Un-oxidized.
1898,*	130.0	4.84	629	20.2	52.1	27.7
1899,	265.4	4.00	1,062	14.3	68.7	17.0
1900,	264.3	5.97	1,578	37.5	52.9	9.6
1901,	254.9	4.90	1,249	17.7	54.9	27.4
1902,	298.4	4.59	1,369	18.5	63.6	17.9
1903,	270.3	3.85	1,041	17.1	70.7	12.2
1904,	222.5	5.75	1,279	44.7	35.7	19.6
Average,	243.7	4.84	1,180	25.7	55.5	18.8

* Filter started Jan. 1, 1898.

Pounds of Nitrogen applied to, stored in, oxidized, etc., in Sand Filters.

Following are several tables of data further to illustrate storage, oxidation, etc., of nitrogen in sand filters. The first of these tables presents figures showing the actual amount of nitrogen, expressed in pounds per acre of filter surface, which has been applied to the various sand filters, stored in these filters, removed by or disappearing from the filters, appearing as nitrates in the effluent of the filters, and appearing as unoxidized nitrogen in the effluents. This table is of interest in showing (1) how small a percentage of the applied nitrogen remains stored in these filters (although this small percentage gives in the course of years an amount of stored nitrogen that is relatively large), and (2) how large a percentage of nitrogen is cared for and changed in other ways than becoming nitrified and passing away as nitrates and nitrites in the effluent of each filter. It will be seen that of the total amount of nitrogen applied to each of the 9 sand filters given in the table, the largest percentage remaining in a filter is in Filter No. 6, namely, 5.9 per cent., and the smallest amount in Filter No. 100, 2.3 per cent., — Filter No. 6 having been operated seventeen years at the time of the examination of sand with the results upon which these figures are based, and Filter No. 100 seven years. The percentage of applied nitrogen appearing as nitrates in the effluents of these filters has varied greatly. With the larger sand filters, namely, Filters Nos. 1, 5A, 6 and 9A, the largest percentage of the applied nitrogen appearing oxidized in any effluent has been in the effluent of Filter No. 1, namely, 53.4 per cent., and the smallest percentage in the effluent of Filter No. 5A, namely,

44.7 per cent. The amount of nitrogen appearing unoxidized in the effluent has also varied greatly, as shown in the table, and the amount which has disappeared, that is, has neither been detected as oxidized or unoxidized nitrogen in the effluents, nor as being stored at the present time in the sand of each filter, has been a large and variable quantity, varying in the case of the large sand filters included in the table from 16.4 per cent. from Filter No. 1 to 46.2 per cent. from Filter No. 5A.

Table showing Nitrogen, in Pounds per Acre, applied to, stored, appearing in Effluent and Lost from Various Sand Filters.

Filter Number.	Date of Sand Analysis.	Days operated.	Pounds of Nitrogen.					
			Applied.	Stored in Sand.	In Effluent.	Lost.*	In Effluent.	
							Oxidized.	Un-oxidized.
1,	Oct. 10, 1904,	5,264	132,384	5,036	105,730	21,618	70,778	34,952
5A,	Mar. 1, 1898,	3,187	94,427	3,081	47,610	43,736	42,056	15,554
6,	Oct. 10, 1904,	5,262	110,060	6,447	73,366	30,247	56,771	16,585
9A,	Oct. 10, 1904,	4,369	114,228	5,406	81,222	27,600	59,104	22,118
13A,	Mar. 7, 1897,	1,898	81,382	4,165	58,147	19,070	56,875	1,272
19,	Mar. 7, 1897,	2,169	107,820	6,751	73,260	27,809	41,335	31,925
100,	Feb. 1, 1905,	2,217	216,412	4,956	152,396	59,060	119,341	33,055
116,	Mar. 25, 1901,	780	71,888	2,456	46,325	23,107	41,084	5,241
118,	Mar. 25, 1901,	735	77,531	3,666	50,020	23,845	42,456	7,564

* Not corrected for nitrogen in original sand or for nitrogen in sand removed by scraping.

Corrections which may be applied to tables of nitrogen in sand: —

Nitrogen removed by Scraping; All Previous to the End of 1893.

Filter No. 1,	3,558 pounds per acre.
Filter No. 6,	1,208 pounds per acre.
Filter No. 9A,	591 pounds per acre.

Table showing Per Cent. of Applied Nitrogen, stored in Sand Filters.

Filter No. 1,	3.8	Filter No. 19,	6.3
5A,	3.3	100,	2.3
6,	5.9	116,	3.4
9A,	2.3	118,	4.7
13A,	5.1		

Table showing Pounds of Nitrogen per Acre at Different Depths in Sand of Sewage Filters Nos. 1, 5A, 6, 9A, 13A, 19, 100, 116, 118.

Filter Number.	Date of Sand Analysis.	Days operated.	Pounds of Nitrogen in Sand.					
			First Foot.	Second Foot.	Third Foot.	Fourth Foot.	Fifth Foot.	Total.
1, . . .	Oct. 10, 1904,	5,264	3,224	773	440	354	240	5,036
5A, . . .	Mar. 1, 1898,	3,187	1,475	444	438	275	449	3,081
6, . . .	Oct. 10, 1904,	5,262	4,289	1,301	521	336	–	6,447
9A, . . .	Oct. 10, 1904,	4,369	3,526	927	388	304	261	5,406
13A,* . . .	Mar. 7, 1897,	1,393	3,220	396	257	199	93†	4,165
19,‡ . . .	Mar. 7, 1897,	2,169	5,651	611	206	148	135	6,751
100,§ . . .	Feb. 1, 1905,	2,217	2,861	701	760	623‖	–	4,956
116,§ . . .	Mar. 25, 1901,	780	1,708	255	178	172	143‖	2,456
118,§ . . .	Mar. 25, 1901,	735	2,857	327	194	146	142	3,666

* Settled sewage applied. † Six inches.
‡ 1890–93, regular sewage applied; 1894–97, chemical precipitated sewage applied.
§ Septic sewage applied. ‖ Nine inches.

Table showing Average Nitrogen Conversion, etc., of Filters operated with Untreated Sewage.

Filter Number.	Period operated.	Volume of Sewage applied (Thousand Gallons per Acre per Day).	Nitrogen applied (Parts per 100,000).	Per Cent. of Applied Nitrogen.			
				In Effluent.		Lost.*	Oxidized + Lost.
				Oxidized.	Un-oxidized.		
1, ...	1888–1904,	71.3	4.25	53.4	18.1	28.5	81.9
2, ...	1888–1904,	87.0	4.25	52.6	12.2	35.2	87.8
4, ...	1888–1904,	23.6	4.31	47.8	5.8	46.4	94.2
5A, . . .	1891–1898,	79.3	4.50	44.7	19.8	35.5	80.2
6, ...	1888–1904,	57.4	4.41	51.3	15.0	33.7	85.0
9A, . . .	1890–1904,	70.3	4.49	51.3	19.4	29.3	80.6
10, ...	1894–1904,	56.5	4.99	55.7	12.0	32.3	88.0
19, ...	1890–1892,	66.7	3.27	60.2	3.1	36.7	96.9
29, ...	1890–1892,	25.7	3.31	63.8	6.6	29.6	93.4
30, ...	1890–1894,	55.1	3.34	76.6	4.8	18.6	95.2
15B, . . .	1892–1897,	374.0	4.25	34.1	18.8	47.1	81.2
16B, . . .	1892–1897,	367.4	4.25	29.8	23.8	46.4	76.2
5B, . . .	1898–1904,	96.4	4.94	48.2	23.7	28.1	76.3
80, ...	1897–1898,	90.7	4.10	33.0	8.5	58.5	91.5
95, ...	1897–1900,	96.6	4.29	63.6	2.8	33.6	97.2

* Nitrogen applied which did not appear in the effluent, including nitrogen in the sand and nitrogen set free.

Table showing Average Nitrogen Conversion, etc., of Filters operated with Treated Sewage.

Filter Number.	Period operated.	Volume of Sewage applied (Thousand Gallons per Acre per Day).	Nitrogen applied (Parts per 100,000).	Per Cent. of Applied Nitrogen. In Effluent. Oxidized.	Per Cent. of Applied Nitrogen. In Effluent. Un-oxidized.	Per Cent. of Applied Nitrogen. Lost.*	Per Cent. of Applied Nitrogen. Oxidized + Lost.
Operated with Settled Sewage.							
13A, . . .	1894–1897	162.1	4.34	65.6	6.0	28.4	94.0
Operated with Strained Sewage.							
14A, . . .	1894–1899	276.0	3.64	70.2	7.2	22.6	92.8
Operated with Precipitated Sewage.							
19, ...	1894–1897	207.4	4.67	63.2	7.8	29.0	92.2
Operated with Andover Septic Sewage.							
A. E. S. F.,† . .	1899–1902	118.0	7.22	25.8	45.2	29.0	54.8
Operated with Septic Sewage.							
100, . . .	1896–1904	243.7	4.84	55.5	18.8	25.7	81.2
116, . . .	1899–1900	208.8	5.32	56.9	7.3	35.8	92.7
118, . . .	1899–1900	254.8	4.99	54.9	9.6	35.5	90.4
Operated with Effluent from Filters Nos. 15B and 16B.							
12A, . . .	1892–1897	570.7	0.90‡ 2.26§	23.6‡	7.3‡	3.5§	27.1

* Nitrogen applied which did not appear in the effluent, including nitrogen in the sand and nitrogen set free as gases.

† A. E. S. F., Andover Experimental Sand Filter. ‡ Unoxidized. § Total.

Table showing Average Nitrogen Conversion, etc., of Filters operated with Treated Sewage — Concluded.

Operated with Effluent from Filters Nos. 135 and 136.

Filter Number.	Period operated.	Quantity applied (Thousand Gallons per Acre per Day).	Nitrogen applied (Parts per 100,000).	Per Cent. of Applied Nitrogen. In Effluent. Oxidized.	Un-oxidized.	Lost.*	Oxidized+ Lost.
185, . . .	1902-1903	834.2	1.80† 3.96‡	37.2†	44.4†	9.2‡	46.4

Operated with Settled Effluent from Filters Nos. 135 and 136.

Filter Number.	Period operated.	Quantity applied (Thousand Gallons per Acre per Day).	Nitrogen applied (Parts per 100,000).	Oxidized.	Un-oxidized.	Lost.*	Oxidized+ Lost.
217, . . .	1903	1,987.0	1.58† 3.98‡	15.8†	67.7†	6.7‡	22.5
224, . . .	1904	496.1	1.94† 4.26‡	17.5†	12.4†	32.0‡	49.5

* Nitrogen applied which did not appear in the effluent, including nitrogen in the sand and nitrogen set free as gases. † Unoxidized. ‡ Total.

Conversion of Nitrogen by Municipal Sewage Filtration Areas.

At the beginning of this discussion of nitrogen disposal, on page 210, the statement was made that with the Lawrence filters receiving strong but stale sewage a greater percentage of nitrogen is nitrified in the filter than in the municipal areas of the State, from the surface of many of which much organic matter is from time to time removed. The truth of this statement is shown by a following table, giving the percentage of the applied nitrogen that is oxidized and appears as nitrates in the effluents of these areas, the figures of these tables being obtained from the data given in a report upon "The Examination of Sewer Outlets and the Effect of Sewage Disposal" in the report of the Board for 1903, page 305. It will be noticed from the following tables that this percentage is very much lower than is the case with the Lawrence filters, only one area showing over 50 per cent. of the applied nitrogen appearing nitrified in its effluent, and few showing even 30 per cent. of the applied nitrogen nitrified, the average amount of nitrogen that appears as nitrates being only 24.9 per cent. of the total nitrogen applied. The average amount of the total nitrogen that is unaccounted for, that is, that does not appear in the effluents of these

areas, is noticeably larger than with the Lawrence filters, showing plainly the removal of much matter from the surfaces of these areas, the average amount removed in this way, stored, and disappearing by nitrogen liberation being 61.3 per cent. of the nitrogen applied, judging by the analyses of sewages and effluents covering a series of years, as given in the table.

In this calculation of the amount of nitrogen oxidized at these municipal areas and the amount appearing unoxidized in their effluents, a certain amount of error enters that does not enter in the calculation of these factors in connection with the Lawrence filters. That is to say, at the areas a certain amount of ground water is mixed with the true sewage effluent. The amount of ground water present in most of these effluents, however, is not great enough to decrease materially the figures of oxidized nitrogen given on the table or to increase the figures showing unoxidized nitrogen.

Table showing Conversion of Nitrogen by Municipal Sewage Filters in Massachusetts.

Area.	Years included in Results on Table.	Parts per 100,000.			Per Cent. of Applied Nitrogen.		
		Average Applied Nitrogen.	Nitrogen in Effluent.		In Effluent unoxidized.	In Effluent oxidized.	Unaccounted for (not appearing in Effluent).
			Unoxidized.	Oxidized.			
Andover, . . .	1900-1903	7.02	0.96	1.07	13.7	15.2	71.1
Brockton, . .	1897-1903	4.73	0.14	2.18	3.0	41.0	56.0
Clinton:							
East underdrain,	1900-1903	5.66	1.01	0.70	17.8	12.4	69.8
West underdrain,	1900-1903	5.66	0.68	0.92	12.0	16.2	71.8
Concord, . . .	1901-1903	1.20	0.02	0.74	1.7	61.7	36.6
Framingham:							
East underdrain,	1893-1903	5.10	0.27	1.16	5.3	22.7	72.0
West underdrain,	1893-1903	5.10	0.18	1.01	3.5	19.8	76.7
Gardner, . . .	1892-1903	3.21	0.80	0.54	25.7	17.4	56.9
Hopedale, . .	1901-1903	2.75	0.85	1.14	30.9	41.5	27.6
Leicester, . .	1897-1903	3.78	0.93	0.93	24.6	24.6	50.8
Marlborough, . .	1892-1903	4.28	0.67	0.85	15.6	19.9	64.5
Natick, . . .	1897-1903	1.71	0.27	0.50	15.8	29.2	55.0
Pittsfield, . .	1903	3.23	0.28	0.69	8.7	21.4	69.9
Southbridge, . .	1900-1903	2.14	0.22	0.16	10.3	7.5	82.2
Spencer, . . .	1898-1903	2.32	0.22	0.71	9.5	30.6	59.9
Stockbridge, . .	1900-1903	1.48	0.19	0.23	12.8	15.5	71.7
Westborough, . .	1900-1903	2.67	0.60	0.75	22.4	28.1	49.5

TOTAL ORGANIC MATTER IN SAND FILTERS NOS. 1, 6 AND 9A, AS SHOWN BY DETERMINATIONS OF COMBUSTIBLE MATTER OR LOSS ON IGNITION OF THE SAND FROM THESE FILTERS.

When Filters Nos. 1, 6 and 9A, $\frac{1}{200}$ of an acre in area, were first put into operation, a determination was made of the total organic matter on the sand grains; that is, the per cent. in weight lost when portions of the sand used were heated to a red heat for a given period. At the end of 1904, determinations were again made with samples collected from different depths in each filter, and the results are given in a following table. These determinations show — calculating as organic matter all matter consumed when sand is heated to a red heat — that at the beginning of operation in 1888 Filter No. 1 had upon its sand grains .42 per cent. of organic matter, or in the entire filter 468 pounds of organic matter, the total weight of sand in this filter being 111,330 pounds. At the end of 1904, after seventeen years of operation, the increase of organic matter was 823 pounds, making the total amount present 1,291 pounds. Four hundred and fifty pounds, or more than 50 per cent., of this increase was in the upper foot of the filtering material. In Filter No. 6 the increase was from 529 to 1,092 pounds; 563 pounds, or about 75 per cent., of the total increase was in the upper foot of the filtering material. With Filter No. 9A the increase has been from 969 to 1,759 pounds, or 81 per cent.; and 71 per cent. of this total increase of organic matter is stored in the upper foot of filtering material. These determinations are of value, supplement the determinations and calculations of the actual amount of nitrogenous matter present given in a previous portion of this report, and show clearly that the stored *nitrogenous* matter is but a small percentage of the entire stable organic matter that has accumulated in these filters, resistant to such bacterial actions as result in the rapid production of nitrates, passage of nitrogen into the air, etc. They also aid in a clear understanding of the greater compactness of the upper portion of the filter due to stored organic matter. Tables showing the results follow.*

Total Nitrogen and Total Organic Matter stored in Filters Nos. 1, 2 and 9A.

	Stored Nitrogen (Pounds).	Total Organic Matter (Pounds).
Filter No. 1,	25	1,291
Filter No. 2,	32	1,029
Filter No. 9A,	27	1,759

* The figures of total organic matter presented in these tables are undoubtedly somewhat large, owing to the method of determination. More accurate methods are being used during 1905.

Total Organic Matter stored in Filter No. 1 at Different Depths, as shown by Determinations of Loss on Ignition.

Depth in Inches.	Loss on Ignition (Per Cent. by Weight).	Corrected Loss.	Pounds of Sand between Depth.	Pounds Loss at Given Depth.	Pounds Loss per Acre at Given Depth.
0–6,	2.58	2.11	11,123	234.7	46,940
6–9,	2.51	2.09	5,561	116.1	23,220
9–12,	2.20	1.78	5,561	99.0	19,800
12–15,	1.05	0.62	5,561	34.5	6,900
15–18,	0.91	0.49	5,561	27.3	5,460
18–24,	0.90	0.48	11,123	59.9	11,980
24–36,	0.86	0.44	22,246	97.9	19,580
36–48,	0.82	0.40	22,246	89.0	17,800
48–60,	0.71	0.29	22,246	64.2	12,840
Total pounds,	-	-	-	822.6	164,520

Total Organic Matter stored in Filter No. 6 at Different Depths, as shown by Determinations of Loss on Ignition.

Depth in Inches.	Loss on Ignition (Per Cent. by Weight).	Corrected Loss.	Pounds of Sand between Depth.	Pounds Loss at Given Depth.	Pounds Loss per Acre at Given Depth.
0-6,	4.01	3.14	12,142	381.2	76,240
6–9,	2.82	1.95	6,071	118.4	23,680
9–12,	2.07	1.20	6,071	72.8	14,560
12–15,	1.97	1.10	6,071	66.8	13,360
15–18,	1.43	0.56	6,071	40.0	8,000
18–24,	1.33	0.46	12,142	55.9	11,180
24–36,	1.08	0.22	24,284	54.7	10,940
36–48,	0.85	-	-	-	-
Total pounds,	-	-	-	789.8	157,960

Total Organic Matter stored in Filter No. 9A at Different Depths, as shown by Determinations of Loss on Ignition.

Depth in Inches.	Loss on Ignition (Per Cent. by Weight).	Corrected Loss.	Pounds of Sand between Depth.	Pounds Loss at Given Depth.	Pounds Loss per Acre at Given Depth.
0-6, ...	2.62	2.12	10,585	230.2	46,040
6-9, ...	2.58	2.08	5,292	107.2	21,440
9-12, ...	2.08	1.58	5,292	83.6	16,720
12-15, ...	1.39	0.80	5,292	42.4	8,480
15-18, ...	0.94	0.44	5,292	23.3	4,660
18-24, ...	0.64	0.14	10,585	15.2	3,040
24-36, ...	0.62	0.12	21,170	25.4	5,080
36-48, ...	0.59	0.09	21,170	19.1	3,820
48-60, ...	0.58	0.08	21,170	16.9	3,380
Total pounds, . . .	-	-	-	563.3	112,660

Acidity or Alkalinity of the Effluents of Sewage Filters as an Index of Good or Poor Purification.

During the investigation in regard to the removal of organic matter from sand filters discussed in previous pages, determinations were begun in order to learn the degree of alkalinity of the effluents of filters of various kinds. In the determination of this alkalinity various indicators have been used, but methyl-orange and gallein are the only two which have been found of practical value. Neither is affected by carbon dioxide; and methyl-orange does not indicate organic acids, while gallein does. The results obtained by the two indicators were practically the same, however, indicating the absence of organic acids from the effluents tested. The determinations made upon the effluents of the small Filters Nos. 265, 266, 267, 268 and 269 (see pages 207–209), and also upon the effluents of the large sand filters in operation at the station, show clearly that when the most complete purification and the highest nitrification are occurring in these filters, their effluents are either acid or only slightly alkaline, and that the poorer the nitrification, the greater is the degree of alkalinity of the effluents. As shown in a following table, the effluents of Filters Nos. 1, 4, 5, 6, 9A and 10 were all slightly acid when examined in September, when nitrification was high; while in December, when nitrification was lower, the effluents of nearly all these filters were slightly alkaline. The different character of the effluents of contact and intermittent-continuous filters in this respect is also clearly shown by the table. Notwithstanding high nitrification in intermittent-continuous Filters Nos. 135 and 136,

enough free ammonia, etc., is always present in their effluents to cause high alkalinity, and this characteristic is even more pronounced in the effluents of contact filters giving low nitrification. The higher the free ammonia and the lower the nitrates, the greater the alkalinity, is the general rule. Filters of fresh sand not yet exhausted of its carbonates, or constructed of sand containing a greater percentage of carbonates than Lawrence sands, may produce effluents which do not follow this rule.

Table showing Results of Determinations of Alkalinity of Sewage and Effluents.

Samples from —	September.		October.		November.		December.	
	Methyl-orange.	Gallein.	Methyl-orange.	Gallein.	Methyl-orange.	Gallein.	Methyl-orange.	Gallein.
Regular sewage,	-	-	-	-	26.0	26.0	28.4	28.4
Filter No. 1, .	−1.3	−0.5	−2.0	-	−2.0	−2.0	1.0	1.0
2, .	1.2	1.2	1.0	0.8	0.5	-	0.1	0.1
4, .	−0.4	−0.3	0.0	0.0	0.2	-	−0.1	−0.1
5, .	−3.6	−1.5	−1.7	−0.9	−1.1	−1.1	3.1	3.1
6, .	−0.6	−0.5	−0.6	-	0.5	-	−1.3	−1.3
9A, .	−1.6	−1.0	−1.5	−1.0	−2.2	−2.1	1.3	1.3
10, .	−0.2	−0.2	0.0	0.0	−0.5	−0.5	−0.8	−0.8
100, .	0.4	0.4	0.2	0.2	0.2	0.2	4.8	4.8
135, .	1.2	1.2	8.4	8.2	2.4	2.3	6.0	6.0
136, .	3.2	3.2	16.4	16.4	5.6	5.6	12.4	12.4
175, .	10.6	10.8	10.0	10.0	10.4	10.4	2.0	2.0
176, .	17.8	17.6	13.6	13.6	16.4	16.2	5.6	5.6
221, .	6.6	6.6	15.6	15.2	21.0	21.0	16.0	16.0
222, .	7.4	7.6	6.8	6.8	12.2	11.8	16.4	16.4
224, .	1.2	1.3	4.2	4.2	2.3	2.3	1.0	1.0
232, .	-	-	690.0	650.0	650.0	640.0	360.0	360.0
233, .	2.4	2.5	12.0	12.0	14.4	14.4	13.0	13.0
234, .	8.2	8.0	21.2	21.2	84.0	-	18.0	18.0
235, .	0.0	0.0	3.6	3.6	4.6	4.2	3.6	3.6
236, .	7.0	7.2	29.2	29.2	23.0	23.0	20.0	20.0
237, .	4.8	4.8	12.0	12.2	11.6	11.6	12.4	12.4
238, .	13.2	13.2	27.6	27.6	-	-	-	-
241, .	45.6	36.0	-	-	36.0	34.0	-	-
242, .	1.8	1.8	1.6	-	1.0	1.0	-	-
247, .	15.6	16.0	17.6	17.6	19.0	19.0	15.2	15.2
248, .	7.2	7.2	31.2	31.2	30.0	30.0	19.2	19.2
249, .	2.4	2.4	5.0	5.0	2.9	3.0	1.2	1.2
250, .	2.2	2.2	5.5	5.5	2.2	2.2	0.5	0.5

Experiments to identify the Acid in Acid Sewage Effluents.

Examinations were made of effluents which were found to be acid, and this acid was shown to be a mixture of nitric and hydrochloric acid. An example of this follows.

One hundred cubic centimeters of the effluent of Filter No. 5B, having a reaction of —4.5, were evaporated. As the acidity of the residue was 0, acid equivalent to 4.5 parts calcium carbonate was driven off, and there was also a loss, during the evaporation, of .67 part of nitrogen as nitric acid. This .67 part of nitrogen was equivalent to 2.4 parts of calcium carbonate, hence the acid equivalent to the remaining 2.1 parts of calcium carbonate must have been due to some other acid. To determine this other acid, 100 cubic centimeters of the effluent of Filter No. 5B were distilled under reduced pressure, and a portion of the effluent of Filter No. 9A, having a reaction of —1.6, was treated in the same way, with the following results: —

Effluent of Filter No. 5B.

	Parts.		Parts.
Acidity of sample, ...	—4.5	Nitrogen as nitrate in distillate, . .	0.572
Acidity of residue, ...	0.0	Chlorine in distillate, ...	1.88
Acidity of distillate, ...	—4.4		

0.572 parts nitrogen = 2.1 parts calcium carbonate.
1.88 parts chlorine = 2.6 parts calcium carbonate.

4.7

Effluent of Filter No. 9A.

	Parts.		Parts.
Acidity of sample, ...	—1.6	Nitrogen as nitrate in distillate, . .	0.227
Acidity of residue, ...	0.0	Chlorine in distillate, ...	0.25
Acidity of distillate, ...	—1.6		

0.227 parts nitrogen = 0.82 parts calcium carbonate.
0.25 parts chlorine = 0.35 parts calcium carbonate.

1.20

The nitrogen as nitrate and chlorine as hydrochloric acid in the distillate account within the limits of error for the acidity of the distillate and the original sample.

Similar results were obtained from a solution containing free HNO_3 and sodium chloride in the same amounts as in these effluents.

These results show that the acidity is due to free nitric and hydrochloric acids, and the hydrochloric acid is probably liberated from the sodium chloride by free nitric acid. Theoretically, if diluted nitric acid is added to a dilute solution of sodium chloride, the sodium chloride gives up part of its base to the nitric acid, so that there will be equivalent amounts of each acid free in the solution.

Total Organic Nitrogen (Kjeldahl Determinations).

During the year a large number of Kjeldahl determinations of the organic nitrogen in sewage and the effluents of sewage filters have been made. It has long been recognized that albuminoid ammonia determinations, while of great value in sewage analysis, give a percentage of the total organic nitrogen present that varies with the age and quality of the sample of sewage examined. For this reason, Kjeldahl determinations are of greater value and significance. The monthly averages of practically all the Kjeldahl results are given in the regular tables of analyses of sewages and effluents in various portions of this report. They add very materially to these tables, and show more clearly than the albuminoid ammonia determinations the actual amount of nitrogen present in the sewage used at the station. There is presented here a table summarizing the Kjeldahl results, and showing the percentage that the organic nitrogen, determined as albuminoid ammonia, is of the actual organic nitrogen. Studying this table, it will be seen that practically 45 per cent. of the organic nitrogen in the effluents of all classes of sewage filters in operation at the station is obtained by the albuminoid ammonia method. In the samples of unfiltered sewage collected at the station after this sewage has passed through a 2½-inch pipe, 4,400 feet long, reaching from the sewer to the station, 39 per cent. of the nitrogen is found by the albuminoid ammonia method; and 38 per cent. of the nitrogen in the stale sewage reaching the Andover filtration area is also found by this method. Fresh sewage flowing in the Lawrence Street sewer yields only 28.5 per cent. of its organic nitrogen by the albuminoid ammonia determination.

Kjeldahl determinations of the nitrogen in sewage after this sewage has been filtered through filter paper show that a greater percentage of the nitrogen in solution than of the total nitrogen is detected by the albuminoid ammonia determination. This result is in line with previous work, and indicates that the organic matter in solution is the most easily oxidized, and hence the first to putrefy.

Average of Kjeldahl Ratios. [Figures represent Percentage that Nitrogen determined as Albuminoid Ammonia is of Total Nitrogen.]

1904.	Average Effluents of Filters.			Regular Sewage.		Average Sewage.	Andover Sewage (Settled).		Effluent of Filter No. 222 (Andover).	Lawrence Street Sewage.	
	Contact.	Trickling.	Sand.	Unfiltered.	Filtered.	Unfiltered.	Unfiltered.	Filtered.	Unfiltered.	Unfiltered.	Filtered.
January,	-	-	-	-	-	-	38.0	41.9	-	21.0	25.3
February,	-	-	-	-	-	40.2	34.0	33.8	-	22.6	15.5
March,	-	-	-	-	-	34.4	25.1	24.1	-	31.8	34.7
April,	-	-	-	-	-	32.3	28.1	28.2	-	35.4	41.7
May,	-	-	-	-	-	41.7	32.5	26.5	-	33.6	27.2
June,	-	-	-	-	-	46.8	46.0	49.2	-	28.2	25.7
July,	-	-	-	43.1	48.5	42.5	47.3	53.4	-	23.8	37.1
August,	46.6	47.4	-	44.3	47.8	40.6	43.7	46.8	-	32.7	32.2
September,	47.3	46.5	-	49.7	54.0	44.5	46.6	55.8	44.5	31.0	27.5
October,	47.1	43.1	42.3	40.5	42.4	37.7	36.1	48.6	46.4	24.2	25.1
November,	44.5	43.6	48.3	35.6	39.6	32.6	36.7	41.5	47.5	29.5	23.4
December,	38.9	42.0	44.4	25.6	25.3	30.1	40.5	39.8	39.5	28.8	24.7
Average,	44.9	44.5	45.0	39.8	44.4	38.5	37.9	40.8	44.5	28.5	28.3

Bacteriology and Biochemistry of Sewage Purification.

Much attention has been given during the past ten years to the study of the bacteria in sewage and in the effluents from various types of sewage filters. The data concerning the numbers of bacteria in samples from these sources have been published annually, as a portion of the routine analytical work, to show the degree of bacterial purification accomplished by the various filters, septic tanks, etc. Much information has also been acquired as to kinds of bacteria, as to the removal of bacteria of certain types, and as to the biochemical reactions occurring in filters and the types of bacteria causing the reactions. A summary of these data is here given.

During the years 1896–99, the special bacteriological investigations were devoted to the determination of the kinds of bacteria in sewage before and after treatment by different methods, especially the bacteria in septic sewage and in the effluents from filters operated with septic sewage. Twenty species of bacteria were found to be of common occurrence in samples of this class, and the per cent. which each species formed of the total number of bacteria in the samples examined, and the per cent. of the samples examined which contained each species, are shown in Table No. 1, together with the average number of bacteria per cubic centimeter, the per cent. of the total number of bacteria which liquefied gelatin in four days, and the per cent. of the total number of bacteria which would grow at body temperature.

In this table a number of the species are designated by names. As this work was one of comparative and quantitative species determination, rather than a detailed study of the species themselves, it is of minor importance that the true identity of the species be established. While the species were completely studied as far as was possible by the methods in vogue at that time, many of the data at present considered necessary for identifying bacterial species were not obtained, and the names given should be considered as indicating only approximately the class or group of organisms in which the species would be included. The determination of the per cent. of the total bacteria which will grow at body temperature has a special significance, in that disease germs grow best at that temperature, and the bacteria which fail to develop under these conditions could not be of pathological importance. It will be noted that not only do the septic tank and the two filters studied remove a large percentage of the total bacteria, but also that the removal of the bacteria which are able to grow at body temperature is much greater than that of the other kinds.

TABLE NO. 1.—*Showing Species of Bacteria in Sewage, Septic Sewage and in the Effluents of Filters receiving Septic Sewage.*

	SEWAGE.		SEPTIC SEWAGE.		EFFLUENT OF FILTER No. 100.		EFFLUENT OF FILTER No. 103.	
	AVERAGE NUMBER OF BACTERIA PER CUBIC CENTIMETER.							
	1,446,000.		528,000.		56,500.		26,900.	
	Per Cent. of Samples Present in —	Per Cent. of Total Bacteria.	Per Cent. of Samples present in —	Per Cent. of Total Bacteria.	Per Cent. of Samples present in —	Per Cent. of Total Bacteria.	Per Cent. of Samples present in —	Per Cent. of Total Bacteria.
Liquefy gelatin,	-	16.0	-	9.5	-	6.8	-	11.1
Grow at body temperature,	-	33.6	-	26.1	-	36.9	-	28.0
B. coli,	-	2.0	-	8.1	-	18.3	-	22.2
B. subtilis,	100.0	4.2	84.0	1.6	100.0	3.4	100.0	5.0
B. vulgaris,	0.0	0.0	6.0	0.2	13.0	0.2	5.0	0.1
B. megatherium,	8.0	0.2	5.0	0.3	7.0	0.1	7.0	0.1
B. prodigeosus,	0.0	0.0	16.0	0.1	0.0	0.0	0.0	0.0
B. hyalinus,	85.0	4.1	86.0	2.0	60.0	1.3	45.0	0.8
B. flavescens,	13.0	0.4	11.0	0.8	3.0	0.1	3.0	0.2
B. stoloniferus,	23.0	0.6	10.0	0.7	0.0	0.0	3.0	0.2
B. aerogenes,	53.0	2.1	46.0	1.4	43.0	0.4	28.0	1.1
Ps. putida,	100.0	16.0	79.0	12.6	100.0	17.0	100.0	15.6
Ps. ochracea,	68.0	5.4	62.0	1.5	56.0	0.3	62.0	1.1
Str. proteus,	13.0	0.4	28.0	0.9	23.0	0.3	25.0	2.6
Sp. No. 059,	-	1.6	-	5.8	-	2.5	-	3.1
Sp. No. 062,	0.0	0.0	14.0	0.7	0.0	0.0	0.0	0.0
Sp. No. 063,	0.0	0.0	14.0	7.6	0.0	0.0	0.0	0.0
Sp. No. 077,	87.0	2.1	69.0	1.5	67.0	0.9	77.0	1.2
Sp. No. 078,	0.0	0.0	4.0	0.1	0.0	0.0	0.0	0.0
Sp. No. 079,	17.0	0.9	11.0	2.8	3.0	0.2	3.0	0.1
Sp. No. 082,	0.0	0.0	1.0	0.1	0.0	0.0	3.0	0.4
Sp. No. 090,	62.0	4.3	47.0	3.5	30.0	1.0	25.0	0.6

During October and November, 1901, studies were made of a few of the sewages applied to and effluents of sewage filters of coarse materials, the investigations at this time being devoted to a determination of the ratio of liquefying bacteria, spores and B. coli to the total number of bacteria. The significance of the B. coli determinations is too well known to require

discussion, the removal of this type indicating the removal of other non-spore-bearing disease germs. The studies of the presence of spore-bearing types were undertaken to determine roughly what would be the fate of spore-bearing disease germs, such as the bacillus of anthrax. The results of these studies show clearly that, while there is a material reduction in the total number of bacteria and in the number of bacteria of non-spore-bearing types by passage through the septic tank and through contact and continuous-intermittent or trickling filters, there is no perceptible reduction in the numbers of spore-bearing bacteria.

TABLE NO. 2.— *Showing the Passage of Spore-bearing Bacteria and B. Coli through Septic Tanks and Sewage Filters.*

SAMPLES FROM—	BACTERIA.			SPORES.			B. COLI.
	Average Number per Cubic Centimeter.	Per Cent. which Liquefied Gelatin.	Average Number of Types which Liquefy Gelatin.	Average Number per Cubic Centimeter.	Per Cent. of Total Bacteria.	Average Number of Types per Sample.	Per Cent. of Total Bacteria.
Sewage, . .	2,427,000	7.7	4	61	0.0029	5	4.00
Septic sewage, .	1,382,000	6.8	4	59	0.0052	6	0.86
Filter No. 100, .	99,400	10.6	2	40	0.0520	2	0.11
Filter No. 103, .	131,600	11.1	1	38	0.0970	2	0.30
Filter No. 137, .	688,000	7.6	2	38	0.0070	2	0.20
Filter No. 135, .	3,000	33.0	2	142	4.7000	1	-
Filter No. 136, .	7,000	29.0	3	43	0.6100	3	-

During 1902-1904, inclusive, extensive studies were made of the passage of B. coli through sewage filters. While B. coli, as has been pointed out many times in previous reports, cannot be considered to be a disease germ, nevertheless, as regards length of life under a variety of unfavorable conditions, it is very similar to the bacillus of typhoid fever, and from its study in sewage effluents we may draw inferences as to what would be the effectiveness of these filters in removing that organism. From the results obtained it is evident that sewage filters of coarse materials, operating at high rates, will not remove all the bacteria of the colon type. On the other hand, intermittent sand filters may remove all, or at least a large proportion of these germs at certain times. The large Filters Nos. 2 and 4, filled with fine sand and operated at low rates, have been particularly efficient in this respect, B. coli being always absent from 1 cubic centimeter samples of the effluents from these filters, and were only occasionally found when 100 cubic centimeters of the water were examined. The percentage removal of B. coli during treatment by different methods has been as follows:—

Septic Tank A removed an average of 46 per cent. of the B. coli, the removal varying from 71 per cent. in March, 1904, to none in April of the same year.

Of the sand filters receiving raw sewage, Filters Nos. 2 and 4 removed practically all of the B. coli; Filters Nos. 6 and 10 removed over 99 per cent.; Filter No. 9A removed over 98 per cent.; and Filters Nos. 1 and 5 removed about 97 per cent. of the B. coli.

Filter No. 100, a sand filter, removed over 98 per cent. of the B. coli from the septic sewage with which it was operated.

Of the contact filters operating with raw sewage, Filter No. 221 removed nearly 49 per cent., and Filter No. 176 removed over 71 per cent.; while Filter No. 103, which received septic sewage, removed over 76 per cent. of the B. coli applied. Filter No. 175, which received strained sewage, removed only a very small percentage of the B. coli.

Both of the intermittent-continuous or trickling filters, constructed of coarse materials, and operated with raw sewage at high rates, showed a high percentage removal of the test organism, Filter No. 135 removing over 99 per cent., and Filter No. 136 about 97 per cent. In the two tables following are shown the results of this investigation, Table No. 3 showing the average monthly number of B. coli in the samples from the different sources, and Table No. 4 showing the percentage removal of the test germ by different methods of treatment.

TABLE NO. 3. — *Showing Average Monthly Number of B. Coli per Cubic Centimeter in Sewage and the Effluents from Sewage Filters.*

SAMPLES FROM —	Jan., 1902.	Feb., 1902.	July, 1902.	Dec., 1903.	Jan., 1904.	Feb., 1904.	March, 1904.	April, 1904.	May, 1904.	June, 1904.
Lawrence Street sewage, .	-	-	-	48,300	48,700	116,900	73,500	67,500	231,000	111,000
Station sewage, . . .	-	-	-	110,000	97,600	76,500	57,200	41,500	144,000	87,800
Septic sewage, A, . .	-	-	-	40,000	52,800	32,800	16,500	53,800	86,400	47,100
Effluent of Filter No. 1, .	12,000	4,700	450	7,300	450	2,300	7,700	1,900	65	200
" " 2, .	0*	0*	0*	0*	0*	0*	0*	0†	0†	0*
" " 4, .	0†	0†	0†	0*	0*	0*	0*	0*	0*	0*
" " 5, .	3,500	1,100	2,500	2,200	6,700	5,100	3,900	400	275	95
" " 6, .	-	-	1,040	0*	250	1,400	600	1,600	21	500
" " 9A, .	0	0	0	2,000	5,900	425	400	150	3	95
" " 10, .	550	600	24	1	30	140	300	24	5	0*
" " 100, .	-	-	-	1,100	170	600	140	1,800	650	1,000
" " 103, .	13,500	16,300	65	17,300	10,300	11,800	1,700	10,000	15,300	-
" " 135, .	295	0	1,600	190	300	2,400	350	140	1,400	-
" " 136, .	550	400	6,800	1,800	1,900	4,000	1,900	900	5,500	-
" " 175, .	13,700	3,600	-	22,800	40,000	35,300	15,000	19,000	33,000	44,000
" " 176, .	11,500	7,200	-	29,300	35,000	16,300	6,800	36,000	42,400	8,500
" " 221, .	-	-	-	25,000	33,200	27,500	16,500	22,500	90,000	99,400

* B. coli absent from both 1 and 100 cubic centimeters.

† B. coli absent from 1 cubic centimeter, but found occasionally in 100 cubic centimeters.

TABLE No. 4. — *Showing Percentage Removal of B. Coli by Different Methods of Sewage Treatment. (Filters Nos. 1, 5, 6, 9A, 10 and 100 are Sand Filters, Filters Nos. 103, 175, 176 and 221 are Contact Filters, and Filters Nos. 135 and 136 are Intermittent-continuous Filters.)*

SAMPLES FROM —	Dec., 1903.	Jan., 1904.	Feb., 1904.	March, 1904.	April, 1904.	May, 1904.	June, 1904.	Average.
By Septic Tank A, . .	68.60	45.90	57.10	71.10	-*	40.00	46.80	46.40
By Filter No. 1, . .	93.87	99.54	96.99	86.54	95.42	99.99	99.77	96.76
5, . .	98.00	93.14	98.33	93.18	99.04	99.81	99.89	96.96
6, . .	-	99.74	98.17	98.95	96.14	99.99	99.43	99.29
9A, . .	98.18	93.95	99.44	99.30	99.64	99.99	99.89	98.54
10, . .	99.99	99.97	99.82	99.47	99.94	99.99	-	99.92
100, . .	97.25	99.67	98.17	99.15	96.65	99.25	97.87	98.33
103, . .	56.75	80.49	64.02	89.69	81.41	82.29	-	76.40
135, . .	99.83	99.69	96.86	99.39	99.66	99.03	-	99.09
136, . .	98.36	98.05	94.77	96.68	97.83	96.18	-	96.96
175, . .	4.20	16.60	-*	-	-	-	-	-
176, . .	73.36	64.14	78.69	88.11	13.25	70.55	90.32	71.60
221, . .	77.27	65.98	64.05	71.15	45.78	37.50	-*	48.80

* Number of B. coli in effluent higher than in applied sewage.

The determinations of the species of bacteria in sewage and in the effluents of sewage filters, further than determinations of the passage of disease germs through these filters, while of interest, are of little practical value unless they are combined with studies of the biochemical reactions which these bacteria produce in sewage. During 1903–1904 extensive studies were made to determine what biochemical reactions occur in different methods of sewage disposal, what types of bacteria are responsible for these reactions, and the relative numbers of bacteria of the various biochemical groups, together with the amount of change which each type of bacteria is able to produce and the rapidity with which it causes that change.

The detailed results of these investigations are too long for insertion here, and have been separated into two papers, one describing new methods of biochemical analysis, with a discussion of their practical application in the study of sewage disposal systems, and the other dealing with the theoretical and biochemical aspects of the sewage disposal problem.*

* "The Functions of Various Types of Bacteria in the Purification of Sewage." H. W. Clark and Stephen DeM. Gage. Engineering News, Vol. liii, 1905, page 27. "Contribution to the Biochemistry of Sewage Purification; the Bacteriolysis of Peptones and Nitrates." Stephen DeM. Gage. Technology Quarterly, xviii, 1905, page 5. Journal of the American Chemical Society, xvii, 1905, page 327. A complete bibliography of the biochemistry is included in the latter paper, pages 12 to 21 inclusive.

Of the biochemical functions of the bacteria concerned in sewage disposal, the most important are the power to peptonize or liquefy the organic matter in suspension, the power to break down the soluble proteids into ammonia, and the power to convert this ammonia into some stable product, such as nitrates, or into free nitrogen. Denitrification, while in a measure a retrograde process, undoubtedly does occur in sewage filters, and the secondary reactions between the reduction products of nitrates and the intermediate products of peptonization, leading, as they do, to the liberation of nitrogen as the lower oxides and as free nitrogen, are probably of more importance than has formerly been thought to be the case. The studies previously presented in this report showing that in sand filters only about 55 per cent. of the applied nitrogen appears as nitrates in the filter effluents, and results presented in this and previous reports, showing the great disappearance of nitrogen in the operation of contact filters, prove the truth of this statement.

Some three hundred cultures of bacteria common in sewage and in the effluents of sewage filters, carefully selected from the colonies on gelatin plates in such a manner as to represent all of the kinds of bacteria in the sample under analysis, have been examined to determine their ability to produce ammonia in pepton solution, to reduce nitrates in nitrated pepton solution, and to liquefy organic matter in the form of gelatin during a uniform incubation period of seven days. From the data thus accumulated it has been possible to compute the percentage of the total number of bacteria in the individual samples which possess these functions, and to determine the relation between the peptonizing power of these bacteria and their ammonifying and denitrifying powers. That a considerable percentage of the bacteria commonly found in sewage and in the effluents and material from sewage filters is able to produce these reactions to a greater or less extent is shown by the following table: —

Distribution of Ammonifying and Denitrifying Bacteria.

Source.	Percentage of Total Bacteria which —	
	Ammonify Pepton.	Reduce Nitrates.
Sewage,	90	70
Septic sewage,	56	59
Effluent of contact filters,	60	61
Effluent of trickling filters,	59	71
Effluent of sand filters,	70	70
Sand from sewage filters,	90	70

Comparing the results obtained with cultures which liquefied the gelatin with those which did not liquefy, it is found that the liquefiers have an

average ammonifying power nearly twice as great as the non-liquefiers, and that they have a denitrifying power about three times as great as shown by the total reduction of nitrates and nearly four times as great as shown by the production of nitrites. In each group of cultures, both liquefying and non-liquefying, some were found which caused large changes in the nitrogen content and others which caused no change whatever. A study of the individual analyses, however, reveals that, while 30 per cent. of the non-liquefying bacteria were unable to reduce nitrates, only 8 per cent. of the liquefying cultures failed in that function. Again, 32 per cent. of the non-liquefying cultures did not produce nitrites in the nitrate solution, and the same percentage of cultures failed to show any ammonia production in the pepton solution. On the other hand, the number of liquefying cultures which failed to produce nitrites was 15 per cent., or less than one-half as many; and the percentage of cultures which failed to break down pepton into ammonia was only 2 per cent., or one-eighth as many as with the non-liquefying cultures. In other words, as shown by the amount of change and the percentage of cultures reacting, the liquefying cultures are much more active in causing putrefaction and denitrification than are the non-liquefying cultures. The comparative results obtained with liquefying and non-liquefying cultures have been grouped in the following table: —

Table showing the Relation between Peptonization, Ammonification and Denitrification.

	Cultures which do not liquefy Gelatin.	Cultures which do liquefy Gelatin.
Number of cultures examined,	44	113
Per Cent. of Cultures which failed to —		
Reduce nitrates,	30.0	8.0
Produce nitrites,	32.0	15.0
Produce ammonia from pepton,	32.0	2.0
Amount of Nitrates reduced, Parts per 100,000.		
Average,	1.8	5.3
Maximum,	7.0	9.6
Minimum,	0.0	0.0
Amount of Nitrites produced, Parts per 100,000.		
Average,	1.6	6.1
Maximum,	11.0	12.0
Minimum,	0.0	0.0

Table showing the Relation between Peptonization, Ammonification and Denitrification — Concluded.

Amount of Ammonia produced from Pepton, Parts per 100,000.

	Cultures which do not liquefy Gelatin.	Cultures which do liquefy Gelatin.
Average,	0.4	0.7
Maximum,	1.9	5.2
Minimum,	0.0	0.0

Thirty cultures of bacteria, representing the forms most commonly found in sewage and in the effluents from sewage filters, have been studied carefully, to determine the character and amount of change which they will produce in the nitrogenous contents of solutions containing nitrogen in the form of commercial pepton and potassium nitrate. Two solutions, one containing 1 per cent. of pepton and the other 1 per cent. of pepton and nitrogen as nitrates, equivalent to 12 parts of nitrogen per 100,000, were seeded with each of the test organisms, and were kept under observation for three weeks or more. Determinations of the total amount of nitrogen were made on all cultures at the beginning and end of the period of study, and daily determinations were made of the amount of nitrates, nitrites and ammonia present in each. It has been assumed that the reactions produced by bacteria under these conditions might well be produced by the same kinds of bacteria in sewage during its process of purification, should favorable conditions occur. That this assumption is correct will be shown further on.

From the results obtained in this study it becomes possible to state definitely that bacteria common in sewage purification are able to produce ammonia from organic matter, to reduce nitrates to nitrites to ammonia and probably to elementary nitrogen, to liberate nitrogen from solutions of organic matter, either with or without the presence of nitrates or its reduction products, and to fix atmospheric nitrogen, — all of which reactions have been noted by other observers, but about which there has been more or less controversy. Many sewage bacteria also produce the lower oxides of nitrogen as reduction products of nitrates, which oxides play an important part in the further decomposition of the organic matter in solution, either through catalytic action or by direct chemical reaction. Furthermore, certain of these bacteria may produce an oxide or at least a compound of nitrogen intermediate between nitrates and nitrites, which apparently has not been noted hitherto.

The amount of ammonia produced by the different cultures and the rate of ammonification varied considerably, some of the cultures reacting as early as the fourth day, while other cultures, which eventually reacted strongly, did not begin to ammonify until after periods of ten to fourteen

days. Similar phenomena were noted with regard to the reaction of the cultures on nitrates. Some reduced the nitrates rapidly and completely, some denitrified slowly, some reacted only after a fairly long period of incubation, and others caused no change. Some cultures were able to reduce the nitrates to nitrites, ammonia and elementary nitrogen continuously from the start, while with other cultures the reduction to these various bodies occurred consecutively, and with still others one or another of the reduction products was not formed during the period over which the examination of the cultures extended. In a few instances nitrites were produced in quantities far greater than the amount of nitrates; and, if the results are not in error, this can be explained only on the supposition that a direct oxidation or nitrification occurred, caused either by bacterial action or by some undetermined secondary reaction.

In the following table are shown the results of analyses of the various cultures made at the end of their period of incubation. By the use of the determinations of nitrates, nitrites and ammonia, and of the values for total nitrogen by the Kjeldahl method, we have been able to compute the total gain or loss of nitrogen by each culture, and to compare the change in the organic nitrogen with the change in the nitric nitrogen. Eighteen of the thirty cultures showed a loss of nitrogen in the pepton solution, and twelve of the cultures showed a gain in nitrogen. In the nitrated solution, fifteen of the cultures showed a loss of nitrogen, and thirteen showed a gain. Eighteen of the cultures agreed as to gain or loss of nitrogen as determined in the two solutions. Two of the cultures showed no change in the nitrate solution, and ten of the cultures showed a gain or loss of nitrogen in the pepton solution, when the reverse was true in the nitrate solution. With eight of these ten cultures, the gain or loss of nitrogen in one solution or the other was 0.5 part per 100,000 of nitrogen or less, this being the probable limit of error of the Kjeldahl method.

The maximum gain in nitrogen in the pepton solution was 12.0 parts, and the maximum gain in the nitrate solution was 12.1 parts. The greatest losses of nitrogen were 5.0 parts in the pepton solution and 6.6 parts of nitrogen in the nitrate solution. Assuming that the error of the methods is 0.5 part per 100,000, twenty-two of the thirty cultures gained or lost more than this amount in the pepton solution and twenty-three gained or lost more than this amount in the nitrate solution. Comparing the reduction of organic nitrogen by the same culture in the two solutions, with twenty cultures a greater reduction in total nitrogen occurred in the nitrate solution than in the pepton solution, either through increased activity of the bacteria in the presence of nitrates, or, as is more probable, through secondary reactions between the decomposition products of the nitrates and organic nitrogen.

Comparing the reduction of organic nitrogen with the reduction of nitric nitrogen, we find that, of twenty-four cultures which showed a reduction

of organic nitrogen of 0.5 part or more, seven failed to reduce nitrates; while of the six cultures which did not cause any material reduction in the organic nitrogen, three were able to produce a decided reduction of nitrates.

Table showing the Gain or Loss of Nitrogen produced by Cultures of Bacteria in Organic Solution with and without the Presence of Nitrates.

[Parts per 100,000.]

Culture.	Pepton Solution.			Nitrate Pepton Solution.				
				Reduction of —		Determined as —		
	Reduction of Organic Nitrogen.	Determined as Ammonia.	Gain (+) or Loss (—) of Total Nitrogen.	Organic Nitrogen.	Nitric Nitrogen.	Ammonia.	Nitrites.	Gain (+) or Loss (—) of Total Nitrogen.
10	6.0	18.0	+12.0	8.3	2.7	12.0	0	+1.0
16	3.5	7.5	+4.0	0.4	0	1.0	0	+0.6
8	0	2.3	+2.3	0	2.6	2.3	0.8	+0.5
23	0	0.7	+0.7	0.1	0	0.5	0	+0.4
4	0	0.6	+0.6	4.5	6.0	7.5	5.0	+2.0
1	1.6	2.1	+0.5	2.2	0	3.8	0.1	+1.7
29	2.3	2.7	+0.4	3.2	1.5	1.9	4.5	+1.7
12	2.1	3.8	+1.7	2.3	0	1.9	0	—0.4
9	1.1	2.3	+1.2	2.8	5.3	3.8	3.0	—1.8
18	1.8	2.2	+0.4	2.4	2.7	1.8	2.6	—0.7
11	0.1	0.5	+0.4	4.5	6.0	5.0	2.8	—2.7
13	3.3	4.2	+0.9	1.4	0	1.4	0	0
6	6.8	1.8	—5.0	0	1.0	0.6	0.3	—0.1
17	3.0	0.2	—2.8	3.0	2.3	3.0	2.2	—0.1
7	4.5	2.2	—2.3	3.2	3.5	1.8	1.6	—3.3
33	2.0	0	—2.0	2.2	1.5	0.6	0.5	—2.6
24	6.2	4.8	—1.4	8.4	4.5	8.6	1.8	—2.5
36	1.1	0.1	—0.7	1.5	0	0.6	0	—0.9
40	2.9	1.5	—1.4	2.8	2.5	1.9	2.2	—1.2
27	1.5	0.9	—0.6	2.5	0	0.6	0	—1.9
32	5.3	4.8	—0.5	9.0	1.5	3.9	0	—6.6
26	0.4	0.2	—0.2	1.6	0	0.7	0.1	—0.8
38	0.6	0.4	—0.2	2.1	0	1.1	0.9	—0.1
34	1.7	0	—1.7	4.1	2.5	1.7	17.0	+12.1
2	2.4	1.1	—1.3	0	0	0.9	0.1	+1.0
31	3.2	2.4	—0.8	5.5	11.0	3.9	15.0	+2.4
41	2.3	1.8	—0.5	3.1	2.5	2.1	4.0	+0.5
30	0.5	0.3	—0.2	0	2.5	4.7	0	+2.2
25	0.5	0.3	—0.2	4.9	9.0	2.7	15.0	+3.8
22	3.1	3.0	—0.1	2.3	2.1	2.6	1.8	0

In order to make these biochemical studies of practical value as methods for sewage analysis, it is necessary that they be expressed quantitatively and according to some definite formula. The liability of a change in the character of the sewage by the action of its bacterial contents or by the action of the bacteria in the filter depends upon the number of bacteria at work and upon the individual power of those bacteria to produce the changes in question, this being called the potential of the sewage under the given conditions. The quantitative expression of the potential can be called the coefficient, this coefficient being the product of the amount of chemical change which the individual bacteria are able to produce in a definite time by the numbers of bacteria which are producing that reaction. For convenience, the amount of change produced in a solution containing 0.1 per cent. of pepton, a solution containing 0.1 per cent. of pepton and potassium nitrate equivalent to 12 parts per 100,000, and in standard gelatin, during seven days' incubation at 20° C., has been selected as a standard, and the number of bacteria in the sample has been expressed as millions of bacteria per cubic centimeter. Thus the numerical expression of the total ability of the bacteria in a sample to produce ammonia from organic matter is the ammonifying coefficient; of the total ability to reduce nitrates is the denitrifying coefficient; and the total ability to liquefy albuminous matter is the liquefying coefficient.

The term nitrogen-liberating coefficient used here is the expression of the ability to liberate nitrogen from nitrates, and is independent of the total gain or loss of organic nitrogen previously discussed. The determination of these coefficients is as follows: each colony on a gelatin plate from any sample represents an aliquot portion of the total number of bacteria in the sample, and the amount of ammonia produced from organic matter by this culture, expressed as parts of ammonia per 100,000, is the ammonifying power of the culture. The ammonifying power of the culture multiplied by the estimated number of bacteria of that type in the sample expressed as millions of bacteria per cubic centimeter becomes the ammonifying coefficient of the type of bacteria, and the sum of the ammonifying coefficients of all the types in a given sample becomes the ammonifying coefficient for the sample. The denitrifying coefficient and the nitrogen-liberating coefficient are determined in a similar manner. The liquefying coefficient of each type of bacteria is obtained by multiplying the depth of liquefaction in millimeters produced in gelatin by the culture inoculated onto the surface of the gelatin, in seven days' incubation at 20° C., by the number of millions of bacteria of that type in the sample; and the sum of the liquefying coefficients of the different types of bacteria in the sample is the liquefying coefficient of the sample.

During the first six months of 1904, a considerable number of sewage and sewage effluents were examined by these methods. Inspecting the results of these examinations as compiled in the following table, it will be

noted first that there is considerable variation in the coefficients as determined for Lawrence sewage at different times, and also that the coefficients for the Andover sewage are much greater than those for the Lawrence sewage. Taking the septic sewages, we find that there is considerable increase in the ammonifying coefficients over those of the sewage entering the septic tanks, in both Septic Tanks A and D-1, in which the sewage at this time was receiving from twenty to twenty-four hours' storage. With the septic sewages D-1, D-2, D-3, D-4 and D-5, which were receiving respectively one, two, three, four and five days' storage, an interesting fact is noticed, in that the ammonifying, denitrifying and nitrogen-liberating coefficients were steadily reduced with increased storage. Comparing the effluents of contact Filters Nos. 103, 175 and 176, with the effluents of intermittent-continuous Filters Nos. 135, 136 and 189, the variation in free ammonia as determined by chemical analysis agrees fairly well with the variation in the ammonifying coefficients. In these two types of filters the nitrate-reducing and nitrogen-liberating coefficients of the contact filters, in which the action is more or less anaerobic, are many times higher than those of the intermittent-continuous filters, in which the action is almost entirely aerobic.

Inspecting the biochemical and chemical analyses of samples from the out-of-door Filters Nos. 1 to 10 inclusive, collected during the winter months, we find in nearly every case high ammonifying coefficients accompanied by high free ammonia, as determined by chemical analysis, and high denitrifying coefficients correlated with considerable free ammonia and nitrites and low nitrates.

Comparing the results obtained from these winter samples with the results obtained from samples examined during the latter part of June and the early part of July, when the filters had recovered from the cold weather and were doing first-class work, we find that the effluents from Filters Nos. 1, 2, 5B, 6 and 9A, which showed some ammonifying power when examined in the winter, had lost this power when nitrification had become more active within them. The effluents from Filters Nos. 1, 2, 5B, 6 and 9A, all showed considerable power to reduce nitrates and liberate nitrogen during the cold weather, but such power was lacking when examined again in warm weather. The effluents from Filters Nos. 4 and 10, which continued to nitrify actively during the winter, did not show any ammonifying, denitrifying or nitrogen-liberating powers, either winter or summer.

These results are further evidence that during exceptionally cold weather the nitrifying bacteria are more or less inactive, and that much of the change going on in a filter is accomplished by bacteria of other types which are apparently capable of performing their work at low temperatures. The results of the determinations of the various coefficients, together with a portion of the results of chemical analyses of the same samples, are shown in the following table: —

Table showing Results of Biochemical Examinations of Sewages and the Effluents from Sewage Filters.

Samples from—	1904.	Bacterial and Biochemical Analysis.						Chemical Analysis (Parts per 100,000).		
		Bacteria per Cubic Centimeter.	Per Cent. of Bacteria which liquefy Gelatin.	Ammonifying Coefficient.	Denitrifying Coefficient.	Nitrogen-liberating Coefficient.	Liquefying Coefficient.	Free Ammonia.	Nitrites.	Nitrates.
Station sewage, . . .	Feb. 25,	2,350,000	8.5	0.28	2.03	1.83	-	4.80	-	-
Station sewage, . . .	Mar. 8,	5,650,000	1.8	0.61	1.96	0.70	-	3.50	-	-
Station sewage, . . .	June 27,	1,750,000	7.0	1.08	6.70	2.14	-	6.60	-	-
Sewage for Septic Tank A,	Feb. 29,	4,500,000	3.3	1.18	6.62	5.38	-	3.80	-	-
Septic sewage A, . .	Feb. 29,	2,700,000	2.8	1.39	5.14	3.27	-	4.00	-	-
Sewage for Septic Tank D,	Mar. 24,	4,150,000	2.4	0.65	2.65	1.32	-	4.90	-	-
Septic sewage D-1, . .	Mar. 24,	4,150,000	6.1	1.47	2.88	1.74	-	7.00	-	-
Septic sewage D-2, . .	Mar. 24,	1,000,000	10.0	0.45	1.43	1.14	-	6.50	-	-
Septic sewage D-3, . .	Mar. 24,	860,000	9.3	0.56	1.35	0.88	-	6.50	-	-
Septic sewage D-4, . .	Mar. 24,	700,000	1.4	0.50	0.75	0.59	-	5.80	-	-
Septic sewage D-5, . .	Mar. 24,	1,300,000	4.6	0.22	1.60	0.53	-	5.50	-	-
Andover sewage, . .	June 9,	3,000,000	7.0	1.51	13.43	6.98	2.21	3.30	-	-
Effluent of Filter No. 108, .	Mar. 16,	590,000	7.6	0.20	1.02	0.31	-	1.56	.0070	0.51
" " 175, .	Mar. 1,	1,350,000	6.7	0.17	1.33	1.21	-	0.86	.1000	4.10
" " 176, .	Mar. 1,	1,040,000	3.9	0.38	1.75	1.34	-	3.20	.0200	0.00
Effluent of Filter No. 135, .	Mar. 16,	150,000	40.0	0.11	0.27	0.16	-	0.46	.0060	2.93
" " 136, .	Mar. 16,	250,000	46.0	0.67	0.67	0.56	-	1.20	.0100	2.09
" " 189, .	Mar. 8,	800,000	7.5	0.11	0.46	0.27	-	2.81	.0120	0.91
" " 222, .	June 9,	1,650,000	6.0	0.63	4.88	2.78	1.42	3.09	.0000	0.05
Effluent of Filter No. 1, .	Feb. 25,	550,000	5.5	0.03	0.44	0.43	-	4.16	.0040	0.77
" " 1, .	July 1,	3,000	7.0	0.00	0.01	0.00	0.04	0.04	.0000	4.62
" " 2, .	Feb. 25,	21,300	2.2	0.00	38.46	0.03	-	1.75	.0048	0.07
" " 2, .	July 6,	20	45.0	0.00	0.00	0.00	0.00	0.76	.0104	4.28
" " 4, .	Feb. 25,	43	46.4	0.00	0.00	0.00	-	0.03	.0006	1.18
" " 4, .	July 1,	60	3.0	0.00	0.00	0.00	0.00	0.70	.0004	5.38
" " 5, .	Feb. 25,	300,000	10.0	0.07	0.21	0.17	-	2.90	.0100	1.60
" " 5, .	July 1,	1,500	17.0	0.00	0.00	0.00	0.01	0.30	.0004	7.14
" " 6, .	Mar. 11,	82,500	8.5	0.04	0.12	0.11	-	3.20	.0020	0.84
" " 6, .	July 1,	2,250	11.0	0.00	0.00	0.00	0.02	0.02	.0002	5.24

Table showing Results of Biochemical Examinations of Sewages and the Effluents from Sewage Filters — Concluded.

Samples from —	1904.	Bacterial and Biochemical Analysis.						Chemical Analysis (Parts per 100,000).		
		Bacteria per Cubic Centimeter.	Per Cent. of Bacteria which liquefy Gelatin.	Ammonifying Coefficient.	Denitrifying Coefficient.	Nitrogen-liberating Coefficient.	Liquefying Coefficient.	Free Ammonia.	Nitrites.	Nitrates.
Effluent of Filter No. 9, .	Mar. 11,	100,000	10.0	0.01	0.13	0.06	-	2.00	.0060	2.22
" " 9, .	June 27,	18	100.0	0.00	0.00	0.00	-	0.02	.0000	3.75
" " 10, .	Mar. 11,	6,800	22.2	0.00	0.01	0.01	-	4.60	.0026	3.57
" " 10, .	July 1,	75	58.0	0.00	0.00	0.00	0.01	0.03	.0002	5.85
" " 100, .	Mar. 1,	80,000	5.6	0.07	0.04	0.02	-	0.96	.0060	0.77

To summarize the results of the biochemical studies, it may be said that the amount of purification which a sewage will undergo in a given time depends on the number of bacteria at work and on the power of the individual bacteria to perform that work; the process of purification being accomplished by the bacteria present in the sewage, working jointly with the bacteria which have found lodgment in the filtering material. The chemical changes which may take place in the sewage in the process of purification may be divided into five groups, as follows: (1) putrefaction, that is, the breaking down of the complex organic matter into simpler forms; (2) nitrification and oxidation, that is, the oxidation of nitrogenous matter into nitrites and nitrates, and of carbonaceous matter into carbonates and carbonic acid gas; (3) denitrification, that is, the breaking down of nitrites and nitrates into simpler nitrogenous compounds; (4) nitrogen liberation, that is, the formation of gaseous nitrogen either by direct bacterial action or by secondary reactions between the reduction products of putrefaction and denitrification; (5) fixation of atmospheric nitrogen, that is, the fixation of molecular nitrogen from the air in the form of ammonia.

Of these reactions, putrefaction and nitrification are to be encouraged. It is an open question whether denitrification should be encouraged or not, depending on whether the liberation of nitrogen incidental during this process overbalances the effect of the decrease in active nitrification.

Nitrogen liberation is desirable provided it can be made to take place in such a manner as to leave the effluent of a filter in a stable and highly oxidized condition, while the fixation of atmospheric nitrogen in a sewage filter is to be avoided if possible. These processes probably all go on to a greater or less extent in sewage filters of the various types. If a filter is so constructed and operated that oxidizing processes are active throughout

the entire depth, the reduction of nitrates is largely prevented, and a large proportion of the nitrogen in the applied sewage will appear in the effluent as nitrates. If, however, the construction and operation of the filter is such that both oxidizing and reducing actions occur, or the reducing action predominates, much nitrogen will be liberated. The effluents of intermittent-continuous filters in good operation contain much of the nitrogen applied, while the effluents of contact filters in good operation show a large disappearance of nitrogen; and this is shown not only by computations of the amount of nitrogen applied and appearing in the effluent of such filters as determined by chemical analyses, but also by the results of the biochemical examination of the effluents from the various classes of filters.

The effluents of intermittent sand filters in good operation also contain considerable portions of the applied nitrogen. During the cold weather, however, nitrification may become inert in filters of this type; and, while the effluents may remain of good appearance, high free ammonia and low nitrates will prevail, combined with a considerable loss of nitrogen.

Loss of Inorganic Nitrogen in Contact Filtration and Intermittent-continuous Filtration during 1904.

On page 213 of the report of 1902, a chapter is given with this heading, and in connection with the chapter on "Storage, Oxidation, etc., of Nitrogen," given in this report, and the chapter upon "Biochemistry of Sewage," the following table is of interest. This table shows that a much greater percentage of the inorganic nitrogen in the sewage applied to intermittent-continuous filters appears oxidized in the effluent of such filters than appears in the effluent of contact filters; in other words, it shows that contact filtration is always favorable to the growth of nitrogen-liberating bacteria, and results in the disappearance of a considerable per cent. of the nitrogen applied to the filters.

Contact Filters.

Filter Number.	Per Cent. of Applied Inorganic Nitrogen appearing in Effluents.	Per Cent. of Inorganic Nitrogen Lost.	Filter Number.	Per Cent. of Applied Inorganic Nitrogen appearing in Effluents.	Per Cent. of Inorganic Nitrogen Lost.
103, ...	43	57	237, ...	85	15
175, ...	68	32	251, ...	71	29
176, ...	56	44	Average, .	61	39
221, ...	45	55			

Intermittent-continuous Filters.

Filter Number.	Per Cent. of Applied Inorganic Nitrogen appearing in Effluents.	Per Cent. of Inorganic Nitrogen Lost.	Filter Number.	Per Cent. of Applied Inorganic Nitrogen appearing in Effluents.	Per Cent. of Inorganic Nitrogen Lost.
135, ...	84	16	235, ...	80	20
136, ...	76	24	236, ...	87	13
233, ...	84	16	247, ...	67	33
234, ...	89	11	Average, .	81	19

Determinations of Turbidity and Sediment.

Since the establishment of the station all records of the amount of matter causing turbidity, or depositing as sediment, in water, sewage, the effluents of sewage filters, etc., have been simply word descriptions; that is to say, the turbidity or sediment has been called "very slight," "slight," "decided," "heavy," etc. Various methods of determining turbidity have been formulated in the past few years, none of which, however, seemed entirely applicable to the station work.

The U. S. Geological Survey has adopted for use in its work the silica or diatomaceous earth standard of Hazen and Whipple.*

This standard is well suited for field work. It is not as well suited for laboratory work, especially in sewage purification studies; and one of its chief defects, as with other standards, is in the failure of the material used to match in color and other physical characteristics the material causing turbidity and sediment in the effluents of sewage filters. To obviate this difficulty, and yet obtain a clearer idea of the actual and relative amount of matter in suspension or appearing as sediment in the effluents of the sewage filters of various types, a standard has been used at the station during a large part of 1904, the basis of which is the actual material passing down through contact or intermittent-continuous sewage filters. This material is taken from the effluent of a filter in good operation, that is, in a state of active nitrification. As collected from the effluent of such a filter, this material is fairly constant in composition, stable, and quite uniform in its color and general physical characteristics. When dried, its loss upon ignition is generally not more than 30 per cent. of its total weight. With the small amounts used in making the standards, slight variations in the exact proportion of mineral and organic matter present have little influence in causing any appreciable variation in uniformity of the standard. Standards made from this matter match closely, in color and appearance, matter in suspension in the effluents of most sewage filters and in many pond and river waters in the New England States. It gives a more nearly correct idea of the actual amount of matter in suspension in a given volume of filter effluent in a sample bottle than can be determined with other standards in use. In making the standard, it is necessary

* As stated by them, "this standard of turbidity shall be such that a water which contains 100 parts of silica per million in such a state of fineness that a bright platinum wire 1 millimeter in diameter can just be seen when the centre of the wire is 100 millimeters below the surface of the water and the eye of the observer is 1.2 meters above the wire, the observation being made in the middle of the day in the open air, but not in sunlight, and in a vessel so large that the sides do not shut out the light so as to influence the results. The turbidity of such a water shall be 100. . . . When the turbidity is below 7, this method cannot be used, and comparisons should be made with the silica standard, properly diluted in bottles or tubes, as described by Whipple and Jackson in Technology Quarterly, Vol. XII., No. 4, December, 1899." (Division of Hydrography, Circular No. 8.)

to keep in a moist condition the material collected from the filters, as when dried it changes its character somewhat, does not become again so well divided into small particles when placed in water in the standard bottles, and higher standards must be taken to match turbidities than actual determinations of matter present in effluents under examination show to be correct. To make up the standard, the amount of sediment present in a given volume of water, thick with the material, is determined, and a sufficient volume of this water is then taken to give the weights of material necessary per liter in the different standards. For instance, a bottle full of the wet sediment used for making standards at the Lawrence Experiment Station contained .4255 gram of suspended matter in 100 cubic centimeters of water; and from this bottle, to make the standard 10.0, enough of this liquid was taken to give 0.1 gram of suspended matter per liter in this standard, other standards being made by taking proportional volumes. The weights and standards are as follows: —

Weight of Material (Grams per Liter).	Standard of Turbidity (Parts per 100,000).	Weight of Material (Grams per Liter).	Standard of Turbidity (Parts per 100,000).	Weight of Material (Grams per Liter).	Standard of Turbidity (Parts per 100,000).
.001	0.1	.04	4.0	.10	10.0
.005	0.5	.07	7.0	.15	15.0
.01	1.0				

To the set of standards, two or three cubic centimeters of a 5 per cent. solution of formaldehyde are added, to prevent change by bacterial action. The standards should be renewed every two or three months, as the matter after a certain period has a tendency to gather in larger aggregations of particles than when the standards are first made up.

The most convenient method of using the standards is to have a set made up in bottles of the same capacity as those in which samples are collected, in order that a direct comparison may be made. In the Lawrence work, gallon bottles are used.

In tables on subsequent pages, showing the average analyses of the effluents of the various sewage filters, the results obtained by the use of this standard are given. These results are of great value, in that they aid in giving a clearer idea of the appearance of these effluents than otherwise can be obtained from tables of analyses. Studying the tables as given in a subsequent portion of this report, it will be seen that from the beginning of July, when the standard began to be used, the highest average turbidity of the effluent of Filter No. 1 for any month was 0.8. That is to say, this effluent even in that month contained on an average only about .008 of a gram of matter in suspension in one liter of water. The effluent of Filter

No. 2 was free from turbidity for three months out of the six during which this standard was used; and during the three months when turbidity readings were obtained, the amount of matter in suspension averaged only .001 of a gram per liter. Throughout six months the effluent of Filter No. 4 did not contain an amount of matter in suspension that could be detected when compared with the lowest standard in use. The highest average turbidity for Filter No. 5B was 2.8, indicating the presence of .028 of a gram of matter in suspension in one liter of effluent. The effluent of Filter No. 6 approximated in quality in this respect the effluents of Filters Nos. 2 and 4, as did also the effluents of Filters Nos. 9A and 10.

The great difference in the quality of the effluents of sand intermittent-continuous, and contact filters, in regard to matters in suspension, is clearly shown by this standard. Turbidities six to fifteen times as great as the turbidities of Filters Nos. 2, 4, 6 and 9 are shown by examination of the tables giving analyses of the effluents of intermittent-continuous Filters Nos. 135 and 136, and the effluents of contact Filters Nos. 175 and 176, these four filters being the best four filters of these two classes in operation at the station.

The standard is of great value also in determining the rapidity with which the matter in suspension in the effluents of sewage filters settles; that is to say, the readings of turbidity and sediment made at different periods after the time of collecting the sample indicate clearly the percentage of the amount of matter primarily in suspension appearing at each reading as suspended matter and as sediment.

Comparisons have been made of the results obtained by this standard with the results of word descriptions formerly used, and result as follows: —

Of 70 turbidity determinations described as "great," 85 per cent. of the numerical readings were 5.0 parts or over; of 62 described as "decided," 71 per cent. were included between numerical readings of 2.0 and 5.0, 3 per cent. were over 5.0 parts and 26 per cent. were under 2.0 parts. Of 36 determinations described as "slight," 92 per cent. of the numerical readings were included between 0.2 and 2.0; 8 per cent. were under 0.2 parts. Of 44 sediment determinations described as "great," 98 per cent. of the numerical readings were 5.0 or over. Of 50 determinations described as "decided," 72 per cent. were included between numerical readings of 2.0 and 5.0 parts; 18 per cent. were over 5.0 parts and 10 per cent. under 2.0 parts. Of 44 determinations described as "slight," 84 per cent. of the numerical readings were included between 0.2 and 2.0 parts; 14 per cent. were over 2.0 parts and 2 per cent. were under 0.2 part.

EXPERIMENTS DETERMINING THE AMOUNT OF TIME TAKEN BY SEWAGE TO PASS THROUGH INTERMITTENT-CONTINUOUS FILTERS OF COARSE MATERIALS OPERATED AT HIGH RATES.

During the year a study has been made with each one of the intermittent-continuous filters, to show the time taken for the passage of sewage through these filters; this being done in order to gain information in regard to the rapidity of nitrification within such filters. The experiments were made in the manner followed at the experiment station in previous years with filters of different classes; that is to say, sewage containing a known amount of salt has been applied to the filter, and careful determinations made of the chlorine in the effluent of the filter before, during and after the period of application of this salt sewage.

With Filter No. 135, containing 12 feet in depth of broken stone, and operated at the time of the experiment at the rate of 1,500,000 gallons per acre daily, it was about one hour after the application of salt sewage before any of it appeared in the effluent. From this time the chlorine increased rapidly, until at the end of three hours the effluent contained 92 per cent. as much chlorine as in the applied sewage; the highest amount found. With Filter No. 136, constructed of the same kind and size of filtering material, but operating at a rate 70 per cent. greater than Filter No. 135, the maximum amount of chlorine present in the effluent was reached within two hours after the application of salt sewage.

Further experiments of the same kind were made with Filters Nos. 247 and 248, constructed of broken stone, and Filters Nos. 233, 234, 235 and 236, constructed of clinker. Filter No. 247 contains 5 feet in depth of broken stone, and at the time the experiment was made the rate of operation was 1,000,000 gallons per acre daily. An increase in the amount of chlorine in the effluent of this filter was appreciable at the end of fifteen minutes, and it increased steadily for about two hours, when the amount became constant, the highest amount found in the effluent being 90 per cent. of the amount applied. With Filter No. 248, containing 8 feet in depth of broken stone, the amount of chlorine present in the effluent increased appreciably at the end of half an hour, and after about two hours became constant, the maximum amount found in the effluent being about 81 per cent. of the amount in the sewage applied. Filters Nos. 233, 234, 235 and 236 are constructed of clinker, Nos. 233 and 235 being constructed of coarse clinker, and Nos. 234 and 236 of a finer grade of clinker. The rate of operation of each of these filters was, at the time of experiment, 1,000,000 gallons per acre daily. With Filter No. 233, containing 5 feet and 9 inches in depth of coarse clinker, the chlorine in the effluent increased appreciably in from fifteen to twenty minutes, and from that time steadily, until at the end of six hours it was fairly constant. Filter No. 234, of the same grade of material, and only 3 feet 10 inches

in depth, showed an increase of chlorine in its effluent in fifteen minutes or less; and the amount became constant one hour from the beginning of the application of the salt sewage. In Filter No. 233 the highest chlorine found in the effluent was 80 per cent. of that in the applied sewage; and in Filter No. 234, 86 per cent. of that in the applied sewage. The deeper filter of fine clinker did not show an increase of chlorine in the effluent until about one and one-half hours from the beginning of application of salt sewage, and the amount found slowly increased for fourteen hours before it became constant. With the shallower filter of fine clinker, the increase in chlorine could be noted at the end of one and one-half hours; it gradually increased for six hours before becoming constant. The maximum chlorine in the effluent of Filter No. 235 was 72 per cent. of the chlorine in the salt sewage; and in the effluent of Filter No. 236, 79 per cent. It was noticeable that in none of the experiments did the chlorine in the effluent become equal to the chlorine in the applied salt sewage, although this salt sewage was applied for many hours; this being due to the fact that a certain volume of sewage previously applied is held even in these filters of coarse material, and this, being slowly given up and mingling with the salt sewage applied, reduces its chlorine content. It is also noticeable, from the greater length of time taken for the chlorine in the effluent of the clinker filters to reach a constant amount, that these filters hold a much greater percentage of sewage in their pores than the filters of broken stone; this being due to the porosity and uneveness of the material, and has, of course, a beneficial effect upon the purification effected by the filters. The following table shows the effect of depth, material in and time of passage of the sewage through these filters upon the nitrification occurring within them: —

Filter Number.	Depth. Ft.	Depth. In.	Material.	Average Rate, 1904 (Gallons per Acre Daily).	Time of Passage of Sewage (Hours).	Nitrates (Parts per 100,000).
135,	12	0	Broken stone,	1,150,000	3	2.95
136,	12	0	Broken stone,	1,938,000	2	2.05
247,	5	0	Broken stone,	925,500	2	0.52
248,	8	0	Broken stone,	963,400	2	2.12
233,	5	9	Coarse clinker,	885,000	6	1.24
234,	3	10	Coarse clinker,	949,000	1	0.73
235,	5	9	Fine clinker,	896,500	14	2.20
236,	3	10	Fine clinker,	908,900	6	0.50

Operation of Septic Tanks.

During the year five septic tanks have been in operation at the station.

Septic Tank A.

Septic Tank A, first put into operation during the latter part of 1897, had been in operation a little more than seven years at the end of 1904.

This is a wooden tank, having a capacity of 225 gallons, and is divided into three compartments. During the year 99,000 gallons of sewage were passed through the tank, or an average volume of 270 gallons per day. The average time of passage of sewage through the tank has varied considerably during the year. Throughout January, February and March, the theoretical time of passage was twenty-four hours; during April, May, June, July and August, twelve hours; and during September, October, November and December, thirty-six hours. Owing, however, to sludge and scum accumulations within the tank, the actual period of passage was much less than this. On the first of April the accumulation of sludge and scum within the tank was so great that the tank was emptied. This was after seven years of operation. At this time 33 per cent. of the capacity of the first compartment was filled with scum, and 48 per cent. with sludge. The second compartment was free from scum, but 67 per cent. of its capacity was filled with sludge. The third compartment was also free from scum, but 42 per cent. of its capacity was filled with sludge. After emptying, the tank was put into operation again, and on September 13, sludge had again accumulated in the tank to the extent of 22 per cent. of the capacity of the first compartment, 17 per cent. of the capacity of the second compartment and 28 per cent. of the capacity of the third compartment. This was the last measurement made during the year. The average analyses of the sewage applied to, and the effluent from, this tank follow. These analyses show that for the entire year 27 per cent. of the total organic nitrogen entering the tank did not appear in its effluent. Divided into periods the removal of organic matter was as follows: during the first period, 28.7 per cent.; during the second period, 19.6 per cent.; and during the third period, 33.9 per cent.

Sewage applied to Septic Tank A.

[Parts per 100,000.]

1904.	Temperature (Degrees F.).	Free Ammonia.	Kjeldahl Nitrogen.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.			
January-March,	51	4.76	1.67	.95	9.73	5.87	2,939,000
April-August,	68	4.28	1.38	.61	13.00	4.75	1,357,000
September-December,	58	4.24	1.62	.72	12.40	4.99	2,388,000

Septic Sewage, Tank A.

January-March,	52	4.60	1.19	.60	9.93	3.81	1,264,000
April-August,	66	4.51	1.11	.56	15.82	3.77	877,000
September-December,	60	4.79	1.07	.62	12.55	4.07	1,627,000

Septic Tanks G and H.

In connection with the operation of Septic Tank A, two similar tanks were also operated during the year, to study further the difference in removal of organic matter from sewage by different periods of passage of sewage through septic tanks. The time of passage through Septic Tank A has been given in a previous paragraph. Through Septic Tank G, operated from the beginning of May throughout the year, the sewage was only six hours in passing; and through Septic Tank H, of the same capacity and operated throughout the same period, the sewage was eighteen hours in passing. Tables showing the average analyses of the sewage entering and of the effluent from these tanks follow; and it will be noted that, as would be expected, considerably better work was done by the tank through which the sewage was the longest time in passing. The effluent of Septic Tank G contained 64.6 per cent. of the total nitrogen in the entering sewage, and the effluent of Septic Tank H 55.4 per cent. of the total nitrogen in the entering sewage. The removal of organic matter, as shown by oxygen consumed determinations, was as follows: in Tank G, 20.8 per cent.; and in Tank H, 30.9 per cent.

Sewage applied to Septic Tank G.

[Parts per 100,000.]

1904.	Temperature (Degrees F.).	Free Ammonia.	Kjeldahl Nitrogen.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.			
June-Dec., inclusive, .	63	3.94	1.61	.81	12.63	5.01	1,845,000
Septic Sewage, Tank G.							
June-Dec., inclusive, .	61	3.85	1.04	.57	12.59	3.97	1,073,000
Sewage applied to Septic Tank H.							
June-Dec., inclusive, .	64	3.73	1.57	.58	13.66	4.89	14,260,000
Septic Sewage, Tank H.							
June-Dec., inclusive, .	62	4.05	0.87	.45	12.59	3.38	1,326,000

Septic Tank F.

This septic tank was in operation throughout the year, and to it was applied the heavy sludge resulting from allowing sewage to stand for sedimentation to take place. This sewage sludge was so applied that it was five days in passing through this tank. The average analyses of the applied sludge or sewage and the effluent of this tank follow, and show that 68 per cent. of the nitrogenous organic matter entering the tank did not appear in its effluent.

Sewage applied to Septic Tank F.

1904.	Temperature (Degrees F.).	Free Ammonia.	Kjeldahl Nitrogen. Total.	Kjeldahl Nitrogen. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
February,	51	5.98	3.65	1.78	17.07	6.96	3,116,000
March,	47	5.80	2.21	0.96	8.09	6.70	3,000,000
April,	52	6.50	2.24	0.91	11.99	6.80	2,450,000
May,	63	4.98	1.71	0.66	18.02	5.42	2,830,000
June,	65	6.50	2.81	0.94	22.27	6.59	2,985,000
July,	78	4.70	0.90	0.47	21.00	5.40	550,000
August,	72	5.73	2.56	0.47	16.36	6.33	1,333,000
September,	69	5.20	1.90	0.58	22.80	5.28	1,100,000
October,	-	6.80	3.81	0.67	9.25	7.49	1,270,000
November,	55	6.65	2.49	1.07	11.85	6.59	3,525,000
December,	50	7.60	4.04	1.69	10.04	5.84	6,120,000
Average,	60	6.04	2.57	0.93	15.34	6.30	2,571,000

Septic Sewage, Tank F.

[Parts per 100,000.]

February,	58	5.56	0.89	0.55	9.96	3.03	892,000
March,	57	6.40	0.80	0.55	7.99	2.75	2,100,000
April,	59	7.05	1.27	0.79	11.64	3.90	375,000
May,	64	6.47	0.81	0.44	14.14	3.61	673,000
June,	64	6.50	0.70	0.30	18.76	2.96	300,000
July,	77	5.30	0.51	0.30	16.88	2.76	160,000
August,	72	5.97	0.87	0.41	17.19	3.23	290,000
September,	68	6.60	0.70	0.31	21.26	2.84	220,000
October,	-	6.30	0.88	0.33	9.35	2.16	640,000
November,	59	6.65	0.73	0.31	12.88	3.22	770,000
December,	55	7.60	0.94	0.41	10.06	4.04	1,150,000
Average,	63	6.40	0.83	0.43	13.65	3.14	688,000

Septic Tank D.

This tank, first put into operation during 1903, was continued during the first four months of 1904. The tank had a capacity of 300 gallons, and was divided into five compartments. It was operated at such a rate that, theoretically, the sewage was twenty-four hours in passing through each compartment, or five days in passing through the tank. A following table presents the average analysis of the entering sewage and effluent of each compartment. The results show a steady decrease of organic matter in the effluent of each compartment, the percentage removal being as follows: after passing Compartment No. 1, 1.3 per cent.; Compartment No. 2, 33.1 per cent.; Compartment No. 3, 37 per cent.; Compartment No. 4, 47.4 per cent.; and Compartment No. 5, 53.2 per cent.

Sewage for Septic Tank D.

[Parts per 100,000.]

1904.	Temperature (Degrees F.).	Free Ammonia.	Kjeldahl Nitrogen. Total.	Kjeldahl Nitrogen. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
Jan.-April, inclusive, .	48	4.66	1.54	.82	11.04	5.18	2,021,000

Effluent from Compartment No. 1, Tank D.

Jan.-April, inclusive, .	46	5.93	1.52	.71	13.93	3.74	1,375,000

Effluent from Compartment No. 2, Tank D.

Jan.-March, inclusive,	46	5.48	1.03	.60	12.93	3.45	697,000

Effluent from Compartment No. 3, Tank D.

Jan.-April, inclusive, .	46	5.68	0.97	.61	11.76	3.05	908,000

Effluent from Compartment No. 4, Tank D.

Jan.-March, inclusive,	46	5.33	0.81	.49	10.66	3.01	782,000

Effluent from Compartment No. 5, Tank D.

Jan.-April, inclusive, .	46	5.30	0.72	.51	10.56	2.79	676,000

LARGE SAND FILTERS IN OPERATION AT THE STATION. — FILTERS NOS. 1 TO 10, INCLUSIVE.

For discussion of experiments in regard to oxidation in these filters, and removal of organic matter from sewage by these filters, see pages 201-216, inclusive.

Filter No. 1.

Filter No. 1 is constructed of 60 inches in depth of coarse sand of an effective size of 0.48 millimeter, and is $\frac{1}{200}$ of an acre in area. On March 24 the surface of the tank was ridged and trenched. On August 28 the surface was again disturbed, the sand levelled, and ridges and trenches again made. The surface sand in the trenches of the filter was raked 1 inch deep three times in January, twice in February, twice in December and once a week during the remainder of the year. On December 24, the trenches were covered with boards. During January, 34 inches of snow and 9¼ inches of ice were removed from the filter; during February, 17 inches of snow and 8 inches of ice; during March, 4 inches of snow; during April, 1½ inches of snow; during November, 1½ inches of snow; and during December, 6 inches of snow and 1⅛ inches of ice.

Filter No. 2.

Filter No. 2 is $\frac{1}{200}$ of an acre in area, and is constructed of 60 inches in depth of fine sand of an effective size of 0.08 millimeter, with circular trenches 1 foot wide and 2 feet deep of medium sand of an effective size of 0.19 millimeter, the surface of these trenches being below the surface of the remainder of the filter and to them the sewage is applied. The surface of the trenches was raked once each week during February, twice during March, three times during December, and once a week during the remainder of the year. On January 13, 1 inch of surface sand from the inner trench and ½ inch from the outer trench was removed and piled on the ridges. On January 15, enough sand was removed from the trenches to increase their depth two inches, and the removed sand piled on ridges. On March 9 the upper six inches of surface sand of the trenches was dug over. Upon April 21 new trenches were constructed between the old trenches, the sand excavated being piled over the old trenches, and the new trenches were filled with sand of an effective size of 0.41 millimeter. During January, 31¾ inches of snow and 14¾ inches of ice were removed; during February, 11¾ inches of snow and 13¼ inches of ice; during March, 4 inches of snow and ⅞ inch of ice; during April, 2 inches of snow; during November, 1½ inches of snow; and during December, 8⅛ inches of snow and ⅛ inch of ice.

Filter No. 4.

Filter No. 4 is $\frac{1}{200}$ of an acre in area, and is constructed of 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, with two circular trenches about 14 inches wide and 12 inches deep, of coarse sand of an effective size of 0.48 millimeter. The surface of these trenches is below the remainder of the filter, and to them the sewage is applied. The trenches were raked 2 inches deep January 26, 1 inch deep during February, twice during March, once during December and once a week during the remainder of the year. On August 28 the trenches were dug over 6 inches deep. On August 29, new trenches were made between the old trenches, one trench 18 inches wide and 1 foot deep; and in the centre of the filter a cylindrical body of sand 48 inches in diameter and 1 foot deep was placed. The fine sand removed from the excavation was piled over the old trenches, and the new trenches, filled with sand of an effective size of 0.41 millimeter. During January, 31 inches of snow and 13¾ inches of ice were removed from the filter; during February, 5 inches of snow and 19½ inches of ice; during March, 1 inch of snow and 1½ inches of ice; during April, 2 inches of snow; during November, 1 inch of snow; and during December, 5¾ inches of snow and 1¼ inches of ice.

Filter No. 5B.

This filter is $\frac{1}{200}$ of an acre in area, and is constructed of 60 inches in depth of a mixture of cinders and ashes from the combustion of soft coal. It was first put into operation March 5, 1898. On November 21, the surface of this filter was trenched and ridged. The surface of the filter was raked once during January, once during February, once during December and once each week during the remainder of the year. During January, 29½ inches of snow and 5⅞ inches of ice were removed from the filter; during February, 12½ inches of snow and 9⅝ inches of ice; during March, 6¼ inches of snow; during April, 1½ inches of snow; during November, 1½ inches of snow; and during December, 8½ inches of snow.

Filter No. 6.

This filter is $\frac{1}{200}$ of an acre in area, and is 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. On March 31, the surface of the filter was levelled and the upper six inches of sand were dug over. On May 4, the surface sand was again dug over. On June 5, the filter was trenched and ridged. The surface of the filter was raked twice in January, twice in February, not at all during December and once each week during the rest of the year. During the period after June 5, sand in the trenches only was raked. During January, 34 inches of snow and 5½ inches of ice were removed; during February, 14 inches of snow

and 5 inches of ice; during March, 4¼ inches of snow; during April, 1½ inches of snow; during November, 1½ inches of snow, and during December, 6 inches of snow and 2¾ inches of ice were removed.

Filter No. 9A.

This filter is $\frac{1}{200}$ of an acre in area, and is constructed of 5 feet in depth of sand of an effective size of 0.17 millimeter. Upon March 30, the surface of the filter was levelled, the sand dug over 6 inches deep and the surface trenched and ridged. Upon May 4, the surface was again levelled and the sand loosened to a depth of 6 inches. On June 5, the surface of the filter was again trenched and ridged. The surface of the filter was raked 1 inch deep three times in January, three times in February, once during December and once a week during the rest of the year; that is to say, during a portion of the year when the surface was trenched, the sand in the trenches only was raked. During January, 37½ inches of snow and 4½ inches of ice were removed from the filter; during February, 35 inches of snow and 7⅝ inches of ice; during March, 3 inches of snow; during April, 1 inch of snow; during November, 1½ inches of snow; and during December, 5½ inches of snow and ½ inch of ice.

Filter No. 10.

This filter is $\frac{1}{200}$ of an acre in area, and is constructed of 5 feet in depth of mixed fine and coarse sand of an effective size of 0.35 millimeter. No underdrains are beneath the sand, except directly above and around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface which is farthest from the underdrains, from the remainder of the surface. To this quarter, the sewage is applied. Over the remainder of the surface is a layer of loam 8 inches in depth. On March 30, the surface sand in that portion of the filter to which sewage is applied was dug over 6 inches deep. On August 23, 8 inches in depth of sand were removed from the portion of the surface to which sewage is applied, and piled on the remaining portion of the filter. On December 23, 1 inch in depth of sand was removed and also piled on the remaining portion of the filter. The surface was raked 1 inch deep once in February, once in December and once a week during the remainder of the year. During January, 38 inches of snow and 10¾ inches of ice were removed from the filter; during February, 19½ inches of snow and 8⅛ inches of ice; during March, 6½ inches of snow and ⅛ inch of ice; during April, 1 inch of snow; during November, 1 inch of snow; and during December, 7¾ inches of snow and 1⅜ inches of ice.

Effluent of Filter No. 1.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage remained on Surface.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Total Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	56,500	51	36	12h. 44m.	Slight.	0.81	3.7960	.1296	7.78	0.74	.0018	1.23	155,900
February,	60,000	51	36	7h. 35m.	Slight.	0.68	4.1860	.1288	7.90	0.78	.0031	1.07	178,700
March,	60,000	49	37	41m.	Slight.	0.94	4.0625	.2170	10.28	1.47	.0073	1.31	179,900
April,	60,000	50	45	35m.	V. slight.	0.55	3.4125	.1120	11.31	4.00	.0125	0.75	22,500
May,	55,400	59	57	13m.	V. slight.	0.41	0.4200	.0440	15.82	5.99	.0012	0.49	8,400
June,	50,800	65	63	7m.	V. slight.	0.22	0.0640	.0440	14.50	4.62	.0006	0.39	10,800
July,	57,700	72	72	9m.	0.3	0.23	0.0260	.0925	15.82	4.08	.0003	0.43	6,200
August,	51,100	71	72	3m.	0.1—	0.21	0.0196	.0392	14.74	7.66	.0002	0.38	3,167
September,	48,500	66	69	11m.	0.1	0.22	0.1817	.0437	16.24	3.35	.0031	0.38	11,500
October,	43,800	57	59	11m.	0.3	0.24	0.6945	.0510	9.61	2.78	.0037	0.49	11,650
November,	60,000	55	51	9m.	0.3	0.25	1.0533	.0673	10.42	2.73	.0123	0.70	10,967
December,	55,500	57	41	5h. 17m.	0.8	0.41	1.2667	.1000	5.19	1.92	.0075	0.80	16,967
Average,	54,900	59	53	-	0.3	0.43	1.5986	.0891	11.63	3.34	.0045	0.70	51,386

Effluent of Filter No. 2.

1904.	Quantity Applied.	Sewage.	Effluent.	Length of Time Sewage remained on Surface.	Turbidity.	Color.	Free.	Total Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	29,200	52	35	24h.	V. slight.	0.48	1.6730	.0784	9.65	0.50	.0192	0.82	3,215
February,	32,000	56	35	* -	V. slight.	0.90	1.5438	.0905	8.01	0.51	.0080	1.10	3,488
March,	26,700	48	36	7h. 39m.	V. slight.	3.45	3.4533	.2013	7.44	0.06	.0070	2.13	2,967
April,	23,100	49	42	2h. 9m.	V. slight.	2.48	5.2967	.1703	10.86	0.97	.0157	1.60	2,000
May,	35,400	60	54	8m.	V. slight.	0.63	4.2317	.0913	11.87	2.23	.0133	0.81	2,600
June,	33,800	65	60	9m.	V. slight.	0.38	2.8000	.0850	18.38	3.53	.0144	0.57	700
July,	38,500	73	70	7m.	0.1	0.34	0.6650	.0505	14.35	3.78	.0102	0.45	296
August,	34,100	71	70	17m.	0	0.23	0.0335	.0217	16.75	4.66	.0035	0.35	1,692
September,	32,300	66	68	10m.	0	0.20	0.0071	.0230	17.11	3.75	.0009	0.26	1,251
October,	29,200	57	60	21m.	0.1—	0.18	0.0027	.0196	6.62	2.19	.0000	0.25	1,750
November,	40,000	53	50	28m.	0.1	0.15	0.0950	.0251	12.83	3.81	.0048	0.37	100
December,	37,000	54	41	3h. 4m.	0	0.17	1.1800	.0440	8.13	1.85	.0272	0.47	1,283
Average,	32,600	59	52	-	-	0.80	1.7485	.0751	11.83	2.32	.0104	0.77	1,779

Effluent of Filter No. 4.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage remained on Surface.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Total Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	13,800	63	34	23h.	0	0.07	0.0160	.0118	9.61	1.21	.0001	0.19	151
February, .	19,200	59	33	24h.	0	0.10	0.0246	.0136	10.88	1.53	.0002	0.21	119
March, .	14,800	52	35	16h. 46m.	0	0.31	0.4942	.0542	11.66	0.76	.0015	0.60	150
April, . .	20,000	49	41	1h. 30m.	0	0.31	0.5613	.0550	9.67	1.59	.0054	0.53	293
May, . .	18,500	59	54	25m.	0	0.09	0.9538	.0393	7.77	4.30	.0089	0.25	1,299
June, . .	18,500	66	61	10m.	0	0.08	0.8000	.0290	10.88	7.31	.0007	0.26	44
July, . .	20,000	72	69	13m.	0	0.11	0.3200	.0265	13.69	5.74	.0003	0.18	34
August, .	17,800	71	69	11m.	0	0.08	0.0148	.0173	15.10	4.95	.0000	0.20	800
September, .	15,400	66	65	2m.	0	0.08	0.0083	.0167	14.32	4.01	.0001	0.20	947
October, .	15,400	57	59	20m.	0	0.10	0.0024	.0123	7.58	2.58	.0000	0.18	345
November, .	20,000	58	54	7m.	0	0.07	0.0019	.0121	9.23	3.04	.0000	0.16	266
December, .	23,000	55	44	4h. 19m.	0	0.11	0.0657	.0140	10.13	4.21	.0256	0.19	600
Average, .	18,000	60	52	-	0	0.13	0.2719	.0252	10.88	3.44	.0036	0.26	417

Effluent of Filter No. 5B.

January, .	80,000	50	36	9h. 49m.	Slight.	0.69	3.5080	.1360	9.01	1.62	.0105	1.06	104,600
February, .	67,200	54	37	7h. 50m.	Slight.	0.62	2.7875	.1210	9.90	1.96	.0085	1.07	105,400
March, .	80,000	51	38	1h. 51m.	Slight.	1.05	3.4300	.1800	9.55	1.88	.0047	1.29	113,000
April, . .	76,900	50	45	32m.	Slight.	0.56	2.1500	.1095	8.69	4.36	.0100	0.83	27,500
May, . .	70,800	59	58	3m.	V. slight.	0.21	0.2900	.0447	10.93	5.29	.0007	0.42	4,900
June, . .	70,800	65	62	2m.	V. slight.	0.20	0.2750	.0460	15.64	5.54	.0002	0.39	950
July, . .	76,900	72	72	5m.	0.2	0.21	0.1000	.0850	15.34	5.69	.0006	0.41	1,600
August, .	80,000	71	72	4m.	0.1—	0.18	0.1172	.0395	15.84	5.11	.0001	0.38	7,400
September, .	61,500	66	69	5m.	0.1—	0.16	0.1184	.0378	15.83	4.62	.0001	0.32	1,500
October, .	61,500	59	59	7m.	2.8	0.29	1.2000	.1080	8.10	2.35	.0007	0.75	55,050
November, .	80,000	63	52	6m.	0.6	0.49	2.2800	.0993	13.90	2.74	.0009	0.91	18,000
December, .	65,200	58	45	47m.	1.0	0.91	2.6167	.1340	8.87	1.35	.0037	1.34	53,050
Average, .	72,600	60	54	-	0.8	0.46	1.5727	.0961	11.80	3.54	.0034	0.76	41,100

Effluent of Filter No. 6.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage remained on Surface.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Total Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	58,500	56	35	7h. 19m.	V. slight.	1.24	3.7200	.1720	8.61	0.46	.0018	1.64	21,800
February, .	57,600	55	36	6h. 6m.	Slight.	1.12	4.2000	.1730	9.03	0.44	.0014	1.52	87,000
March, .	60,000	49	38	2h. 28m.	V. slight.	0.95	4.2750	.1860	9.34	0.98	.0024	1.26	41,500
April, .	48,500	50	44	39m.	V. slight.	0.70	3.3667	.1197	9.94	2.86	.0130	0.99	25,500
May, .	52,200	59	58	9m.	V. slight.	0.25	1.8233	.0497	14.01	7.18	.0185	0.36	4,600
June, .	55,400	65	62	30m.	V. slight.	0.21	0.1280	.0460	16.32	4.54	.0008	0.31	2,500
July, .	60,000	72	72	11m.	0.1—	0.19	0.0084	.0318	14.81	4.60	.0008	0.41	2,600
August, .	58,100	71	72	7m.	0	0.17	0.0069	.0244	15.35	5.20	.0002	0.34	3,100
September, .	46,200	67	68	20m.	0.1—	0.16	0.0249	.0251	12.83	4.06	.0012	0.25	2,325
October, .	43,800	62	58	17m.	0.1	0.21	0.2400	.0380	8.58	2.30	.0058	0.31	12,250
November, .	60,000	55	49	49m.	0.1—	0.31	0.5813	.0693	9.92	2.58	.0037	0.55	40,100
December, .	52,600	56	39	4h. 55m.	0.2	0.23	0.8533	.0593	4.96	1.35	.0079	0.46	14,400
Average, .	54,400	60	53	-	0.1	0.48	1.6023	.0829	11.14	3.05	.0048	0.70	21,500

Effluent of Filter No. 9A.

1904.	Quantity Applied.	Sewage.	Effluent.	Length of Time.	Turbidity.	Color.	Free.	Total Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria.
January, .	60,800	62	38	5h. 42m.	Slight.	0.81	3.2800	.1204	9.85	1.15	.0038	1.15	123,700
February, .	53,600	61	41	9h. 24m.	V. slight.	0.55	3.1725	.1050	9.49	1.76	.0044	0.94	19,700
March, .	60,000	59	42	1h. 28m.	V. slight.	0.60	2.0250	.0870	7.94	2.07	.0078	0.82	39,100
April, .	46,200	62	45	31m.	0	0.29	1.7533	.0567	10.12	5.28	.0110	0.49	2,800
May, .	52,200	60	58	8m.	V. slight.	0.22	0.1547	.0340	14.61	4.59	.0000	0.33	4,100
June, .	55,400	65	64	16m.	V. slight.	0.22	0.0180	.0370	16.57	3.53	.0000	0.38	725
July, .	60,000	73	71	15m.	0.1—	0.20	0.0062	.0329	14.45	3.64	.0005	0.29	1,885
August, .	58,100	71	70	8m.	0	0.18	0.0091	.0317	15.19	5.80	.0001	0.31	590
September, .	48,500	66	68	46m.	0.1—	0.17	0.0803	.0327	14.13	2.52	.0003	0.35	1,975
October, .	41,500	62	59	39m.	0.1—	0.18	0.2125	.0239	9.48	1.80	.0007	0.26	233
November, .	60,000	54	52	1h. 4m.	0.1—	0.28	1.0267	.0513	9.60	2.10	.0006	0.57	1,260
December, .	48,900	61	45	7h. 12m.	1.2	0.49	1.3167	.1000	6.71	1.13	.0021	0.84	13,400
Average, .	53,800	63	54	-	0.3	0.35	1.0046	.0594	11.51	2.95	.0026	0.56	17,400

Effluent of Filter No. 10.

1904.	Quantity Applied.	Sewage.	Effluent.	Length of Time.	Turbidity.	Color.	Free.	Total Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria.
January, .	15,400	54	43	-	V. slight.	0.58	1.7790	.0924	9.20	0.95	.0010	0.71	18,400
February, .	16,000	53	44	13h. 30m.	V. slight.	0.87	3.1100	.1115	9.21	1.29	.0009	1.12	16,000
March, .	16,300	54	39	1h. 22m.	V. slight.	0.72	1.5650	.0967	4.75	0.68	.0015	1.03	19,000
April, .	15,400	57	45	27m.	V. slight.	0.22	2.5000	.0520	11.55	3.92	.0028	0.88	3,070
May, .	17,700	60	56	4m.	V. slight.	0.18	0.2460	.0667	14.97	3.92	.0005	0.30	2,700
June, .	18,500	65	61	2m.	V. slight.	0.18	0.0420	.0255	16.72	4.53	.0004	0.28	1,450
July, .	20,000	72	69	2m.	0.1—	0.18	0.0077	.0307	15.47	4.74	.0002	0.28	322
August, .	20,000	71	69	8m.	0	0.17	0.0051	.0194	15.74	3.40	.0000	0.27	597
September, .	16,200	66	66	13m.	0	0.18	0.0097	.0233	14.59	2.38	.0001	0.23	692
October, .	14,600	62	60	14m.	0.1—	0.17	0.0230	.0218	9.29	2.35	.0000	0.25	730
November, .	20,000	54	53	37m.	0	0.19	0.4307	.0527	12.83	3.36	.0031	0.35	106
December, .	16,700	56	46	3h. 54m.	0.1	0.25	1.4750	.0540	7.80	1.70	.0122	0.60	1,083
Average, .	17,200	60	54	-	-	0.32	0.9328	.0514	11.84	2.77	.0019	0.46	5,338

Sand Filtration of Septic Sewage.

Filter No. 100 is $\frac{1}{20000}$ of an acre in area, and is constructed of 60 inches in depth of sand with an effective size of 0.26 millimeter. This filter was first put into operation Jan. 1, 1898, and was continued throughout 1904. It has always been flooded with the effluent of Septic Tank A. The filter is raked each week, and it was necessary on April 6 to remove 6 inches in depth of clogged sand. The table of average analyses of its effluent follows.

Filter No. 242, constructed of 48 inches in depth of sand of an effective size of 0.41 millimeter, was put into operation February 1, and received the effluent of Septic Tank D at an average rate of 100,000 gallons per acre daily. A table giving the average analysis of its effluent follows.

Effluent of Filter No. 100.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature — Deg. F.		Length of Time Sewage remained on Surface.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
January, .	300,000	58	54	44m.	Slight.	0.65	0.7900	.0940	9.99	3.21	.0310	0.94	63,300
February, .	300,000	50	56	1h. 25m.	Slight.	0.80	0.7500	.1140	8.83	0.80	.0038	1.23	65,000
March, .	288,900	54	58	6h.	Slight.	0.85	1.0425	.1240	8.43	0.49	.0055	1.10	23,300
April, . .	242,300	50	56	45m.	Decided.	1.60	2.3000	.2420	9.05	0.73	.0645	3.24	242,000
May, . .	288,500	64	58	1h. 2m.	Decided.	0.62	0.4100	.0860	12.03	0.72	.0064	0.89	23,800
June, . .	288,500	65	62	1h. 10m.	Decided.	0.41	0.4580	.0990	14.62	1.46	.0054	0.81	9,300
July, . .	103,800	79	72	-	2.5	0.38	5.1000	.2920	16.38	6.12	.1100	2.19	39,000
August, .	200,000	73	68	20m.	0.5	0.31	0.0945	.0470	13.65	2.01	.0040	0.44	6,250
September, .	200,000	68	66	45m.	0.1	0.16	0.2035	.0585	9.95	3.36	.0014	0.28	5,250
October, .	161,500	-	62	-	0.5	0.20	0.1160	.0540	11.75	1.63	.0008	0.33	48,500
November, .	200,000	55	50	-	1.1	-	0.2845	.0555	12.22	2.69	.0016	0.59	18,000
December, .	96,300	56	56	-	4.0	2.00	1.4250	.1320	6.15	1.10	.0360	1.74	-
Average, .	222,500	61	60	-	1.4	0.73	1.0812	.1161	11.09	2.03	.0225	1.15	49,400

Effluent of Filter No. 242.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
February, .	100,000	58	60	V. slight.	0.83	1.0783	.0678	43.12	0.26	.1063	.80	444,400
March, . .	100,000	57	62	V. slight.	1.08	1.3750	.0545	10.80	4.37	.1250	.52	39,800
April, . .	100,000	59	59	Slight.	1.10	0.1167	.0607	12.32	4.20	.2260	.41	75,400
May, . .	91,400	64	65	Slight.	1.00	0.1190	.0580	12.94	4.30	.3200	.72	3,300
June, . .	100,000	64	68	Slight.	0.45	0.0660	.0447	18.71	3.64	.2103	.48	4,700
July, . .	100,000	77	75	0.1	0.44	0.0640	.0380	17.31	5.20	.1300	.37	1,800
August, .	97,800	72	72	0.4	0.58	0.0750	.0260	16.20	5.06	.0067	.29	200
September, .	83,700	68	67	0.1	0.39	0.0660	.0350	16.98	4.18	.0036	.25	82
October, .	61,000	-	61	-	-	0.0740	.0280	9.80	4.48	.0032	.34	230
November, .	100,000	59	55	-	0.22	0.2040	.0360	12.33	5.12	.0075	.48	120
December, .	51,400	55	57	-	0.27	0.5500	.0520	10.02	6.38	.0030	.38	275
Average, .	89,600	63	64	0.2	0.63	0.3439	.0455	16.41	4.29	.1040	.45	51,846

Operation of Contact Filters.

During the year, six contact filters have been in operation at the station, namely, Filters Nos. 103, 175, 176, 221, 237 and 251.

Filter No. 103 ($\frac{1}{20000}$ of an Acre in Area).

Filter No. 103 was a coke contact filter 5 feet in depth, the coke in this filter being of such a size that all would pass through a sieve with a $\frac{1}{2}$-inch mesh and practically none through a sieve with a $\frac{1}{8}$-inch mesh. This filter was continued in operation until June 10, 1904, and at this date it had been in operation six years and six months. This filter always received the effluent of Septic Tank A, and when first put into operation the rate was about 1,000,000 gallons per acre daily, the filter being filled once daily. This rate, owing to the usual loss of open space that takes place during the first two or three months of operation of contact filters, was decreased somewhat; and after several years of operation it was necessary to fill the open space twice daily, in order to obtain a rate approximating that maintained when the filter was started. During 1903, the average rate of operation was 788,500 gallons per acre daily. Towards the end of that year, however, the open space of the filter began to

decrease with considerable rapidity. This continued throughout the first six months of 1904, and finally the clogging was so great that the filter was put out of operation. A considerable percentage of this filling of open space was due to an accumulation of organic matter, but much was due to a breaking down or disintegration of the particles of coke after this more than six years' use, with its consequent saturation. Examination of the coke after the filter was put out of operation showed that the filtering material contained 25 per cent by weight of organic matter. This filter was constructed of ordinary gas-house coke, more or less friable. A new filter to take its place was constructed of hard Pennsylvania coke, the pieces being of practically the same size as those used in Filter No. 103. This filter was called No. 251, and will be described later.

Effluent of Filter No. 103.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
							Albuminoid.						
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
January, .	640,000	53	54	Decided	0.55	1.3900	.1920	.1130	8.62	.58	.0025	1.58	495,000
February, .	288,000	50	56	Decided.	0.90	1.6600	.2020	.1400	8.20	.03	.0012	1.66	315,000
March, .	397,000	54	56	Great.	1.75	1.5600	.1960	.1240	7.65	.51	.0070	1.51	130,000
April, .	589,200	50	51	Decided.	0.73	2.0800	.2500	.1260	11.08	.33	0011	1.36	408,000
May, .	551,500	64	64	Decided.	0.80	1.3000	.1580	.1080	12.48	.02	.0013	1.11	99,800
June, .	487,500	65	60	Great.	0.90	2.3500	.1750	.1520	19.30	.04	.0000	1.60	165,000
Average, .	492,200	56	57	Decided.	0.94	1.7233	.1955	.1272	11.22	.25	.0022	1.47	268,800

Filters Nos. 175 and 176 (Each $\frac{1}{20000}$ of an Acre in Area).

Filters Nos. 175 and 176, first put into operation June 3, 1901, were continued during 1904. Each filter is 5 feet in depth, and is constructed of pieces of coke of such size that all will pass through a sieve having a 1-inch mesh, 75 per cent. through a ½-inch mesh and practically none through a sieve with a ¼-inch mesh. Filter No. 175 has always received sewage that has passed through a coke or coal strainer, and Filter No. 176 has received the regular station sewage. Each of these filters is allowed to rest one week in each six. During the year, Filter No. 175 was operated at the rate of 470,000 gallons per acre daily, and Filter No. 176 at the rate of 465,000 gallons per acre daily. Filter No. 175, receiving a sewage freer from matters in suspension, gave, as usual, the best purification. Tables showing the results of the analyses of the effluents of these filters follow.

Effluent of Filter No. 175.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	506,900	56	58	Decided.	.59	1.8250	.2060	.1370	7.45	2.56	.0290	2.05	990,000
February, .	524,000	55	61	Decided.	.62	0.9000	.1860	.1400	7.31	2.48	.0248	1.25	688,000
March, . .	630,000	50	59	Decided.	.78	0.9800	.2070	.1620	7.28	3.06	.0880	1.48	558,000
April, . .	453,500	51	55	Decided.	.63	1.0200	.1940	.1030	12.98	2.32	.0300	1.15	378,000
May, . .	459,400	59	65	Decided.	.58	0.8563	.2000	.1300	14.51	1.71	.0830	1.88	2,910,000
June, . .	548,500	65	62	Great.	.50	0.4600	.2000	.1150	14.75	1.97	.0040	1.40	580,000
July, . .	548,500	72	72	13.5	.83	0.2625	.2275	.1600	15.01	2.12	.0170	1.79	407,500
August, .	300,900	71	72	7.0	.70	0.6600	.2440	.1700	15.58	0.23	.0020	1.44	775,000
September, .	408,700	65	67	9.0	.60	0.6500	.2640	.1460	17.91	1.08	.0024	1.63	750,000
October, .	441,300	58	63	8.0	.55	1.1600	.2960	.1780	14.01	1.34	.0440	1.09	1,060,000
November, .	486,300	53	58	12.0	.67	1.8000	.3600	.2700	12.91	2.18	.0320	1.88	1,323,000
December, .	326,700	45	58	4.0	.50	1.3500	.1500	.1320	8.88	3.69	.0880	1.16	-
Average, .	469,600	58	63	8.9	.63	0.9895	.2279	.1536	12.38	2.06	.0330	1.48	937,700

Effluent of Filter No. 176.

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	531,600	53	52	Decided.	.58	0.6000	.1740	.1240	6.80	1.93	.0115	1.23	737,500
February, .	515,600	49	56	Decided.	.75	1.1000	.2680	.1300	9.23	0.04	.0013	1.84	1,050,000
March, . .	311,100	50	56	Decided.	.70	3.0000	.2340	.1190	8.00	0.03	.0002	1.64	167,500
April, . .	463,900	51	52	Decided.	.78	3.2500	.3320	.2930	11.48	1.17	.0170	1.50	1,043,000
May, . .	512,700	59	65	Decided.	.63	2.0875	.2175	.1140	13.86	0.32	.0025	1.60	270,000
June, . .	583,800	65	62	Great.	.90	1.8500	.2500	.1300	14.42	0.06	.0006	1.64	375,000
July, . .	601,600	72	72	15.0	.79	0.9450	.2450	.2020	12.72	0.61	.0023	1.96	457,500
August, .	322,600	71	72	7.0	.70	1.0400	.2080	.1780	14.14	1.43	.0800	1.47	725,000
September, .	438,100	65	68	11.0	.63	1.3500	.2460	.1850	15.81	0.02	.0004	1.72	437,500
October, .	447,900	58	63	12.0	.70	2.4000	.3350	.2680	15.29	0.02	.0030	1.29	725,000
November, .	508,700	53	55	12.5	.64	2.0500	.3500	.2700	11.93	1.48	.0095	2.07	958,000
December, .	342,200	45	58	6.0	.53	1.2000	.2000	.1440	8.11	4.09	.1100	1.53	-
Average, .	465,000	58	61	10.6	.69	1.7394	.2550	.1798	11.82	0.93	.0199	1.62	631,500

Filter No. 221.

Filter No. 221 is $\frac{1}{5000}$ of an acre in area, and is constructed of 42 inches in depth of broken stone of such a grade that all the pieces will pass through a sieve with a 1-inch mesh, 25 per cent. through a $\frac{1}{2}$-inch mesh and

none through a sieve with a $\frac{1}{4}$-inch mesh. The underdrains of this filter are constructed of 6 inches in depth of cobblestones laid upon brick channels. This filter was first put into operation July 7, 1903, and during 1904 was operated at a rate of 504,500 gallons per acre daily. Nitrification within this contact filter of broken stone has been very feeble during the year, and in marked contrast to nitrification that occurs within filters of rough and porous material operated in the same manner. The analyses of the effluent of this filter follow.

Effluent of Filter No. 221.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
							Albuminoid.						
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
January, .	560,000	53	48	Great.	0.74	1.9550	.2720	.2160	7.44	.17	.0002	2.46	930,000
February, .	560,000	49	46	Great.	0.75	2.5000	.3080	.2400	7.56	.17	.0011	2.64	970,000
March, . .	560,000	50	46	Great.	1.20	1.9750	.2985	.2140	7.71	.18	.0012	2.52	645,000
April, . .	560,000	51	48	Decided.	1.30	2.8750	.2450	.2160	11.44	.04	.0000	2.04	575,000
May, . .	538,500	59	59	Great.	0.97	2.2300	.3200	.2000	12.10	.03	.0002	2.82	915,000
June, . .	560,000	65	65	Great.	1.45	2.3000	.3550	.2015	11.88	.03	.0006	3.34	850,000
July, . .	560,000	72	72	8.0	0.62	1.7125	.2425	.1600	13.32	.02	.0003	1.83	810,000
August, .	542,200	71	70	8.5	0.70	1.6125	.2625	.1850	12.00	.07	.0060	1.78	905,000
September, .	406,200	65	63	6.5	0.50	1.2160	.2040	.1590	7.91	.51	.0030	1.50	1,395,000
October, .	310,600	58	61	7.0	0.68	1.6800	.3160	.2440	10.36	.04	.0030	1.96	1,200,000
November, .	475,000	53	58	17.0	0.70	2.8500	.4500	.2910	11.55	.35	.0045	2.12	1,405,000
December, .	421,500	45	49	13.0	0.70	2.6500	.3950	.3080	9.07	.07	.0025	3.64	670,000
Average, .	504,500	58	57	10.0	0.86	2.1297	.3057	.2195	10.20	.14	.0019	2.39	856,000

Filter No. 251.

Filter No. 251, $\frac{1}{10000}$ of an acre in area, is constructed of 28 inches in depth of Pennsylvania coke, this coke being of such a size that all will pass through a sieve with a $\frac{1}{2}$-inch mesh and practically none through a $\frac{1}{8}$-inch mesh. This filter was put into operation Aug. 1, 1904, and is flooded with the effluent of Septic Tank A in three doses one hour apart. Following this, the filter stands two hours and is then drained slowly. The average analysis of the effluent of this filter follows.

Effluent of Filter No. 251.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
							Albuminoid.						
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
Aug.-Dec., inclusive, .	585,400	63	60	10.5	.58	2.9678	.2739	.1928	11.37	.23	.0090	1.98	943,000

Filter No. 237.

Filter No. 237, $\frac{1}{20000}$ of an acre in area, is constructed of clinker varying in size from $\frac{3}{4}$ of an inch to $1\frac{3}{4}$ inches in diameter. Clinkers are laid over brick underdrains, and the depth of the filter, including underdrains, is 5 feet 6 inches. The filter receives the effluent of Filter No. 221, and is flooded twice daily. The average rate of operation has been 1,000,000 gallons per acre daily. A table follows, showing the average analyses of samples of effluent collected during the morning and afternoon of each day's operation.

Effluent of Filter No. 237, A.M.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
							Albuminoid.						
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
Average, .	767,000	57	53	9.0	.69	1.0681	.2097	.1372	10.94	.72	.0063	1.49	718,500

Effluent of Filter No. 237, P.M.

Average, .	950,000	57	55	8.2	.65	1.2201	.1957	.1456	10.43	.59	.0120	1.57	552,400

Intermittent-continuous or Sprinkling Filters.

Filters Nos. 135, 136, 189, 233, 234, 235, 236, 247, 248 and 222.

During 1904, ten intermittent-continuous or sprinkling filters have been in operation. Nine of these filters are located at the experiment station, and each is $\frac{1}{20000}$ of an acre in area; and one filter, No. 222, is located at the Andover filtration area, and is $\frac{1}{200}$ of an acre in area.

Some of the filters are constructed of smooth and some of rough and porous materials. They are of varying depths and are operated at differing rates. Filters Nos. 135, 136, 247, 248 and 222 are constructed of broken stone; Filters Nos. 233, 234, 235 and 236 are constructed of clinker; and Filter No. 189 of broken brick.

Filters Nos. 135 and 136 were first put into operation during 1899, and at the end of 1904 had been in operation more than five years. Each filter is 11 feet 10 inches in depth, and is constructed of broken stone all of which will pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a $\frac{1}{2}$-inch mesh and 4 per cent. through a screen with a $\frac{1}{4}$-inch mesh. The sewage is distributed over the surface of these filters, as on all other intermittent-continuous filters at the station, by means of auto-

matic tipping basins. During the year, both of these filters have received regular station sewage, Filter No. 135 being operated at an average rate of 1,150,000 gallons per acre daily, and Filter No. 136 at an average rate of 1,938,000 gallons per acre daily. Operating at these rates, there has been comparatively little difference in the keeping or non-putrescible quality of the effluents, and nitrification has been active in both. The effluent of the filter operating at the higher rate contained, however, approximately twice as much free ammonia, somewhat more albuminoid ammonia and about two-thirds the amount of nitrates of the effluent of Filter No. 135. Each filter produced a practically non-putrescible effluent.

For further information upon the quality of effluents that can be obtained by filtration in this manner through filters of broken stone, Filters Nos. 247 and 248 were put into operation during May, 1904. Each of these filters contains the same grade of broken stone as in Filters Nos. 135 and 136. Filter No. 247 is 5 feet in depth; and Filter No. 248, 8 feet in depth. Each of these filters has been operated at a rate of about 1,000,000 gallons per acre daily. The deeper of these filters produced an effluent containing as high nitrates as in the effluent of Filter No. 136; while in the shallower filter, only 5 feet in depth, nitrification was comparatively inactive, nitrates being only about one-sixth as high as in the effluent of Filter No. 135, of twice as great a depth, but operating at practically the same rate. While both filters were intended to be operated with sewage of the same strength, Filter No. 248 received during the latter part of the year a very much stronger sewage than Filter No. 247, which caused the free and albuminoid ammonia of the effluent of this filter to be somewhat greater than the same bodies in the effluent of Filter No. 247. Neither effluent was as stable as the effluent of the deeper broken-stone filters.

The fifth filter of broken stone, namely, Filter No. 222, $\frac{1}{200}$ of an acre in area, and located at the Andover filtration area, was first put into operation July 13, 1903, and has always received Andover sewage after same has passed through a settling tank. This filter contains 8 feet in depth of broken stone, and is constructed as follows: The original cypress tank used for this filter was 6 feet in depth only, and in order to obtain a depth of 8 feet the sides of the tank were built up with large field stones to a height of 2 feet. For collecting drains, 6-inch Akron drain pipes with open joints are laid across the diameters of the filter, and these pipes extend to within 2 feet of the sides of the filter. Above and around these drain pipes are placed 13 inches of large field stones, some of which are nearly a foot in diameter and on these is placed a layer of 7 inches in depth of small field stone, and above these 54 inches of broken stone, most of the pieces of which are more than 2½ inches in diameter; and, on top of this, a layer of 22 inches of broken stone of a somewhat smaller grade.

The average rate of operation of this filter during the year has been 1,465,000 gallons per acre daily. It has been evident that this filter is constructed, especially throughout its lower portion, of too coarse a grade of material to produce good results at this high rate; and it is also evident that these underdrains of very coarse material have been unnecessary, and that a shallower depth of open underdrains would have been fully as efficient in allowing free flow of effluent and removal of the coarse sediment and in thus preventing clogging of the lower layers. During warm weather nitrification in the filter was active, but during winter weather it was low. During the winter of 1903-04, as stated in the last report, the method of applying sewage was different from that followed in the warm weather; that is, instead of application by means of tipping basins, series of pipes were placed below the surface of the filter. During the winter of 1904-05, however, the tipping basin method was followed, and the filter was covered with a roof of boards. It is of interest to note that during neither winter was there the slightest trouble from cold weather, so far as the operation of the filter and disposal of sewage is concerned.

During the months of January, February and December, 1904, the temperature of the applied sewage was 44, 42 and 47 degrees F., respectively, and the temperature of the effluent was 43, 42 and 47 degrees, respectively; that is to say, the sewage passed through this filter practically without any lowering of its temperature.

As stated previously in this chapter, four intermittent-continuous filters, constructed of clinker, were in operation at the station during the year, namely, Filters Nos. 233, 234, 235 and 236. This study was planned to show the degree of purification of sewage or stability of effluent that can be obtained by filters of this material constructed of different depths and of different grades of material. Each of these filters is $\frac{1}{20000}$ of an acre in area. Filters Nos. 233 and 234 are constructed of clinker, the pieces of which vary in diameter from $\frac{3}{4}$ of an inch to $1\frac{3}{4}$ inches. Filter No. 233 is 69 inches in depth, however, while Filter No. 234 has a depth of 46 inches only. Filters Nos. 235 and 236, each $\frac{1}{20000}$ of an acre in area, are constructed of clinker, the pieces of which vary between $\frac{1}{4}$ of an inch and $\frac{3}{4}$ of an inch in diameter. Filter No. 235 has a depth of 69 inches, while Filter No. 236 has a depth of 46 inches. Each of these filters has open brick underdrains, covered with a fine layer of coarse crushed stone, and each has been operated at the rate of 1,000,000 gallons per acre daily. The tables of analyses of the effluents of these filters follow.

Filter No. 189, $\frac{1}{20000}$ of an acre in area, was first put into operation May 14, 1902, and was discontinued April 30, 1904. This filter was constructed of pieces of broken brick about 2 inches in diameter. During its period of operation in 1904, the average rate was 1,451,000 gallons per acre

daily. While nitrification was generally quite active in this filter, the organic matter remaining in its effluent was but slightly changed by passage through the filter, and hence very putrescible.

Effluent of Filter No. 135.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.		
January, .	1,048,500	53	41	Decided.	0.90	1.2800	.3800	.1540	8.68	3.45	.0030	2.92	90,800
February, .	1,023,200	49	44	Decided.	0.68	0.5200	.2820	.1440	9.56	3.15	.0033	2.14	138,800
March, . .	1,001,000	50	44	Slight.	0.63	0.2507	.2280	.1113	8.61	3.52	.0050	1.79	62,500
April, . .	1,000,000	51	47	Slight.	0.70	0.0600	.2520	.1060	10.70	4.54	.0040	2.12	14,000
May, . .	996,200	59	61	Slight.	0.48	0.3950	.5775	.1350	17.07	6.00	.0087	3.76	16,500
June, . .	994,600	65	67	Decided.	0.72	0.9000	.4640	.1270	14.31	2.59	.0126	3.21	32,000
July, . .	1,476,900	72	71	13.0	0.50	0.5267	.3800	.0803	9.63	2.34	.0061	3.50	34,800
August, .	1,490,400	71	64	5.0	0.36	0.3575	.1290	.0720	19.70	2.94	.0032	1.19	45,800
September, .	1,430,800	65	58	6.0	0.44	0.4750	.1390	.0880	8.80	1.78	.0037	1.17	52,000
October, .	1,011,500	58	58	7.0	0.48	1.0800	.2000	.1300	10.12	1.63	.0079	1.65	315,000
November, .	1,498,500	53	49	6.0	0.46	1.7563	.1900	.1080	9.08	1.59	.0090	1.55	62,500
December, .	833,000	45	48	11.0	0.51	0.8350	.2950	.1160	7.77	1.84	.0110	2.60	62,500
Average, .	1,150,400	58	54	8.0	0.57	0.7047	.2889	.1143	11.17	2.95	.0064	2.30	77,300

Effluent of Filter No. 136.

January, .	1,798,500	53	42	Decided.	0.86	1.4300	.1660	.1270	8.40	2.10	.0047	1.84	50,500
February, .	1,924,800	49	46	Decided.	0.83	1.3500	.2985	.2130	8.68	1.88	.0090	2.27	259,000
March, . .	2,012,600	50	46	Decided.	0.99	1.5900	.2640	.1800	9.07	1.73	.0103	2.19	265,000
April, . .	2,025,400	51	49	Decided.	1.30	1.0500	.3300	.1600	7.67	2.30	.0110	3.27	115,000
May, . .	1,958,500	59	61	Decided.	0.50	0.9675	.4350	.1470	16.06	3.30	.0135	3.11	40,300
June, . .	1,857,000	65	67	Decided.	0.55	0.7675	.6800	.1640	13.80	3.69	.0060	1.54	80,000
July, . .	2,262,300	72	72	13.7	0.55	0.7467	.5000	.1493	10.44	2.46	.0073	3.79	47,800
August, .	2,414,800	71	65	7.0	0.48	1.5775	.1895	.0950	19.91	1.64	.0054	1.79	51,800
September, .	1,500,000	65	60	11.0	0.55	1.0175	.2245	.1010	11.35	1.91	.0082	2.07	46,500
October, .	1,634,600	58	58	10.0	0.57	2.1000	.2500	.2000	10.00	1.00	.0130	1.85	365,500
November, .	2,500,000	53	49	6.5	0.54	2.3125	.2395	.1450	9.15	1.23	.0120	1.71	102,300
December, .	1,370,400	45	48	15.0	0.49	1.7500	.4400	.1300	8.24	1.37	.0150	3.28	62,500
Average, .	1,938,000	58	55	10.5	0.68	1.3883	.3343	.1509	11.06	2.05	.0096	2.39	123,900

Effluent of Filter No. 247.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
May–Dec., inclusive, .	925,500	61	64	8.6	.68	2.8100	.3075	.1981	12.01	0.52	.0216	1.80	390,300

Effluent of Filter No. 248.

May–Dec., inclusive, .	963,400	61	61	10.0	.73	4.0924	.5775	.2813	11.23	2.12	.0572	2.81	409,000

Sewage Applied to Filter No. 222.

[Parts per 100,000.]

1904.	Temperature. Deg. F.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen. Total.	Kjeldahl Nitrogen. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, . .	44	3.44	0.58	.37	1.30	0.71	3.95	3.39	2,740,000
February, . .	42	3.31	0.56	.39	1.42	1.06	3.60	3.31	1,508,000
March, . .	41	2.99	1.06	.69	2.33	1.59	3.77	3.40	1,305,000
April, . . .	43	2.50	1.76	.42	4.61	1.30	3.49	0.96	6,550,000
May, . . .	49	2.58	0.46	.32	1.26	0.87	3.97	2.51	1,757,000
June, . . .	57	3.10	0.54	.28	0.97	0.51	5.06	2.10	1,598,000
July, . . .	62	2.16	0.40	.22	0.63	0.35	4.67	1.70	585,000
August, . .	64	3.65	0.32	.25	0.69	0.44	6.38	2.45	560,000
September, . .	63	4.95	0.82	.47	1.44	0.70	6.44	3.45	1,725,000
October, . .	58	4.97	0.77	.48	1.71	0.79	6.05	3.39	2,320,000
November, . .	53	4.65	0.69	.44	1.50	0.91	5.56	3.56	2,720,000
December, . .	47	2.67	0.41	.27	0.81	0.54	3.28	2.50	1,730,000
Average, . .	52	3.41	0.70	.38	1.56	0.81	4.69	2.73	2,091,000

Effluent of Filter No. 222.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Seven Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.		
January, .	1,472,000	44	43	Slight.	.77	3.5000	.7660	.3596	4.43	0.05	.0082	4.16	2,818,000
February, .	1,459,000	42	42	Slight.	.69	3.1750	.8525	.3125	3.59	0.04	.0025	4.04	2,783,000
March, . .	1,455,500	41	41	Slight.	.68	2.7650	.6530	.2928	3.58	0.09	.0124	2.38	1,073,000
April, . .	1,487,700	43	43	Slight.	.51	2.0938	.2800	.2100	3.25	0.06	.0085	1.59	50,000
May, . .	1,475,700	49	50	Slight.	.38	1.9875	.2863	.1875	3.69	0.45	.0133	1.32	162,000
June, . .	1,490,400	57	58	Slight.	.49	2.3500	.4360	.1900	4.09	0.13	.0192	1.60	1,122,000
July, . .	1,486,700	62	64	2.5	.54	2.1750	.4050	.1450	6.05	0.47	.0645	1.48	424,000
August, .	1,491,900	64	67	2.8	.66	2.5275	.4083	.1600	9.06	1.28	.0598	1.97	370,000
September, .	1,482,000	63	64	2.9	.59	2.3040	.3616	.1572	7.92	2.01	.0416	2.14	435,800
October, .	1,482,600	58	59	4.3	.51	2.0292	.4193	.1500	5.69	1.91	.0290	2.08	201,700
November, .	1,315,500	53	53	5.0	.52	3.0156	.4463	.2185	6.28	0.83	.0233	1.97	493,000
December, .	1,481,400	47	47	3.0	.51	2.9250	.3450	.1863	4.81	0.42	.0173	2.01	758,009
Average, .	1,465,000	52	53	3.4	.57	2.5706	.4733	.2141	5.20	0.65	.0246	2.23	891,000

Effluent of Filter No. 233.

[Parts per 100,009.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.		
Average, . . .	885,000	58	60	9.2	.77	2.7515	.3247	.1755	10.09	1.24	.0377	2.18	418,000

Effluent of Filter No. 234.

Average, . . .	949,000	58	60	11.5	.88	3.4225	.4707	.2431	10.16	0.73	.0768	2.80	717,000

Effluent of Filter No. 235.

Average, . . .	896,500	58	60	7.2	.57	1.3169	.3051	.1312	11.79	2.20	.0791	1.89	962,000

Effluent of Filter No. 236.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
							Albuminoid.						
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
Average, . . .	908,900	58	61	11.0	.77	3.5721	.4411	.2254	11.18	0.50	.0127	2.48	637,300

Effluent of Filter No. 189.

Jan.-Apr., inclusive, .	1,451,500	51	47	-	.86	3.0729	.6200	.2153	7.40	2.13	.0222	2.75	554,200

Double Filtration.

Filters Nos. 224, 249, 250 and 252.

During the year, four secondary filters, namely, Filters Nos. 224, 249, 250 and 252, have been in operation, and have received the effluents of filters of coarse materials.

Filter No. 224 is $\frac{1}{20000}$ of an acre in area, and is constructed of 54 inches in depth of sand of an effective size of 0.27 millimeter. This filter was put into operation Oct. 1, 1903. It receives the effluents of Filters Nos. 135 and 136 after these effluents have passed through a sedimentation basin. The average rate of filtration of this filter for the year, was 500,000 gallons per acre daily, although during a considerable portion of the year the rate was considerably greater than this. At the end of 1904, it was necessary to remove 3 inches in depth of sand. The good quality of the effluent of this filter is shown by the average analysis following.

Filters Nos. 249 and 250, $\frac{1}{20000}$ of an acre in area, were put into operation May 16, 1904, and each is constructed of 60 inches in depth of sand of an effective size of 0.41 millimeter. Each filter receives the effluents of Filters Nos. 135 and 136 after these effluents have passed through a sedimentation basin, and during the year each has operated at an average rate of approximately 700,000 gallons per acre daily. It is intended with these two filters to make a study of surface treatment. Filter No. 249 is never to be dug over to a greater depth than 3 inches, and when it fails to dispose of its prescribed dose, this 3 inches of sand is to be removed. Filter No. 250, on the other hand, will be spaded to a greater depth when necessary. With filters operated at this high rate, this deeper spading will cause sand removal to be ultimately necessary, and perhaps the amount removed may be greater than from Filter No. 249.

Filter No. 252, $\frac{1}{10000}$ of an acre in area, is constructed of 36 inches in depth of coke breeze over 6 inches in depth of brick underdrains. It receives the effluents of Filters Nos. 233, 234, 235 and 236 after passage through a sedimentation tank. The filter was put into operation Aug. 4, 1904. Its average rate of filtration was 1,150,000 gallons per acre daily; and operating at this rate it was necessary to rake the filter nine times, and to remove 1 inch in depth of coke upon October 25.

Effluent applied to Filters Nos. 224, 249 and 250.

[Parts per 100,000.]

1904.	Temperature.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.		
Average, . .	57	3.0	.69	1.2710	.1525	.1194	11.31	2.29	.0258	1.10	524,700

Effluent of Filter No. 224.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
Average, ...	496,100	56	55	0.1	.41	0.1451	.0585	9.90	2.66	.0044	.64	71,700

Effluent of Filter No. 249.

Average, ...	683,700	61	61	0.3	.33	0.1571	.0645	13.26	3.27	.0085	.62	54,960

Effluent of Filter No. 250.

Average, ...	694,000	61	61	0.5	.34	0.1294	.0687	13.28	3.40	.0056	.61	170,200

Effluent of Filter No. 252.

Aug.-Dec., inclusive, .	1,154,000	60	57	0.8	.40	1.9167	.0912	11.23	1.46	.1044	.74	69,500

Miscellaneous Filters.

During the year, a number of filters other than those already described have been in operation, but the results obtained from them have not been of enough significance to warrant much discussion.

Filters Nos. 202 and 203, $\frac{1}{8000}$ of an acre in area, and constructed of $4\frac{1}{2}$ feet in depth of sand of an effective size of 0.27 millimeter, were continued until the end of April, and tables showing the average analyses of the effluents for that period follow. Filter No. 202 received sewage from Septic Tank A and Filter No. 203 regular station sewage. They were both operated at the average rate of 80,000 gallons per acre daily. The object of the experiment, as stated in the last report, was to compare purification of station sewage and septic sewage in duplicate filters. The results during 1904, as during 1903, showed that the filter receiving septic sewage gave a slightly poorer effluent, although nitrification was high in both filters.

Effluent of Filter No. 202.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.		
Jan.-April, inclusive,	80,000	51	59	.21	.0388	.0208	8.60	4.58	.0019	.23	1,888

Effluent of Filter No. 203.

Jan.-April, inclusive,	80,000	52	59	.18	.2646	.0266	10.43	5.17	.0012	.30	2,400

Filters Nos. 209, 211 and 213.

These filters, first put into operation in May, 1903, were continued until the end of April, 1904. Each filter was $\frac{1}{22000}$ of an acre in area, and was constructed of 4 feet in depth of sand of an effective size of 0.27 millimeter. Filter No. 209 was flooded with sewage from the first compartment of Septic Tank D, Filter No. 211 with sewage from the third compartment of Septic Tank D, and Filter No. 213 with sewage from the fifth compartment of Septic Tank D. (For analyses of sewage applied see page 254.) Each of these filters was operated at the rate of 100,000 gallons per acre daily, and following tables show the average analyses of the effluents. It will be seen that there was a very small difference in the degree of purification obtained in each filter.

Effluent of Filter No. 209.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.			Ammonia.			Nitrogen as			
		Sewage.	Effluent.	Color.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
Jan.-April, inclusive,	100,000	46	48	.35	.1858	.0517	11.01	3.71	.0158	.58	6,900

Effluent of Filter No. 211.

Jan.-April, inclusive,	100,000	46	48	.39	.2590	.0508	11.24	4.34	.0102	.54	6,000

Effluent of Filter No. 213.

Jan.-April, inclusive,	100,000	46	48	.44	.2198	.0500	9.92	3.61	.0074	.56	6,940

Filters Nos. 226A, 227A, 228A, 239, 240 and 241.

These small filters were operated in a continuation of the investigation discussed on pages 238–239, inclusive, of the report of the Board for 1903. Each filter was $\frac{1}{224000}$ of an acre in area. Filter No. 226A was constructed of 4½ feet in depth of sterile sand. Filter No. 227A was constructed of 5 feet in depth of unsterilized sand, but the sewage applied was sterilized by heat daily. Filter No. 228A was constructed of unsterilized sand. Filter No. 239 was constructed of 5 feet in depth of sand from the surface of Filter No. 1, Filter No. 240 of 5 feet of sterile sand, the tank also being sterilized, and Filter No. 241 was constructed of 5 feet in depth of sand from the surface of Filter No. 1.

The results from these filters, taken as a whole, were practically the same as the results obtained from the similar series of filters discussed in the last report; and, as the results from Filters Nos. 226A, 227A and 228A were practically the same as the results from Filters Nos. 226, 227 and 228, the analyses of their effluents will not be inserted here.

Two filters, Nos. 239 and 241, each constructed of surface sand from Filter No. 1, were operated as comparison experiments, the sewage applied to Filter No. 239 being fresh Lawrence Street sewage, while that applied to Filter No. 241 was the ordinary station sewage, containing a certain portion of lime. The average analyses of the effluents of these two filters follow; and it is evident that, while oxidation to the stage of nitrification

did not occur to any extent in either filter, still, the removal of nitrogenous matter from the sand was greater in the filter operated with fresh sewage than in the filter operated with sewage to which lime was added, the free ammonia in the effluent of Filter No. 239 being nearly twice as great as the free ammonia in the effluent of Filter No. 241, and the same can be said in regard to the albuminoid ammonias.

Effluent of Filter No. 239.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
Feb.-July, inclusive, . .	41,900	59	61	11.2761	.6106	–	.10	.0008	3.08	440,100

Effluent of Filter No. 241.

Feb.-Dec., inclusive, . .	31,200	58	64	6.6183	.3866	14.01*	.04	.0039	2.43	103,400

* Average for five months.

Purification of Wool Liquor.

Filter No. 232.

This small filter, $\frac{1}{22400}$ of an acre in area, was constructed of 4½ feet in depth of sand of an effective size of 0.27 millimeter. It was flooded with the waste liquor from scouring wool after the wool had first been treated by the naphtha process for removing grease. The filter was put into operation in January, and its use continued throughout the year. Nitrification became active after a short period of operation, and finally the nitrates in the effluent were practically 20 parts per 100,000. Even with this high nitrification, however, the albuminoid ammonia was more than 5 parts per 100,000. Nitrification continued good for a number of months. At the end of this time, an attempt was made to improve the work of the filter by reducing the alkalinity of the applied waste by the addition of sulphuric acid. This was not added in sufficient amounts to make the waste acid, but nevertheless nitrification in the filter decreased rapidly soon after it began to be used. The filter is remarkable in that it is the first one operated with wool liquor at the station in which nitrification has ever occurred without the addition of sewage to the waste before filtration. The average analysis of the effluent follows, together with an average analysis of the wool waste.

Average Analysis of the Applied Liquor and Effluent of Filter No. 232.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.
					Albuminoid.					
		Sewage.	Effluent.	Free.	Total.	In Solution.		Nitrates.	Nitrites.	
Applied wool waste, . . .	-	-	-	31.93	16.07	14.45	59.25	0.31	.0000	206
Effluent, Filter No. 232, . .	12,300	64	64	2.80	6.17	-	50.80	12.24	.0074	71

FILTRATION OF WATER.

A number of water filters have been in operation during the year, and the following subjects have been studied: (1) work of the Lawrence city filter; (2) sand filtration with the addition of copper sulphate to water before filtration; (3) rapid filtration with the use of aluminum sulphate as a coagulant; (4) re-filtration through a sand filter of the effluent of the alum filter; (5) double sand filtration; and (6) germicidal effect of aluminum sulphate.

Lawrence City Filter.

The Lawrence city filter is 2.5 acres in area. It was constructed during 1893, and dividing walls separating it into three sections were built during 1902. The following tables present the average chemical and bacterial analyses of many samples of the Merrimack River water as it flows upon the filter, and of the effluent of the filter collected at different points upon the supply system.

It will be seen by the average analyses that the filter removed 99.5 per cent. of the bacteria in the river water applied to it, and that, whereas all the samples of the applied river water contained B. coli in numbers varying in different months from 12 to 129 per cubic centimeter, only 8.0 per cent. of the one cubic centimeter samples of the effluent of the filter contained this germ, and the number decreased as the water passed through the system to its consumers. It will also be noticed that the organic matter of the river water determined as albuminoid ammonia was decreased 50 per cent. by filtration.

Chemical Analyses.

Merrimack River.

Intake of the Lawrence City Filter.

[Parts per 100,000.]

1904.	Temperature. Degrees F.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.		
Average, ...	51	0.1—	.39	.0126	.0216	.0175	.32	.016	.0003	.54	1.7

Merrimack River — Concluded.

Effluent of the Lawrence City Filter.

[Parts per 100,000.]

1904.	Temperature. Degrees F.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average,	52	0.1—	.44	.0125	.0092	.0085	.33	.040	.0000	.37	2.1

Water from the Outlet of the Distributing Reservoir.

Average,	52	0.1—	.38	.0068	.0093	.0081	.32	.042	.0001	.32	2.0

Water from a Tap at Lawrence City Hall.

Average,	54	0.1—	.37	.0040	.0089	-	.34	.044	.0000	.32	2.0

Water from a Tap at Lawrence Experiment Station.

Average,	52	0	.33	.0030	.0074	-	.32	.042	.0000	.30	2.0

Merrimack River as it flows upon Lawrence City Filter.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Number of Samples tested for B. Coli.	Average Number of B. Coli per c.c.	Per Cent. of Samples containing B. Coli.
January,	10,100	25	62	100
February,	7,200	24	51	100
March,	4,000	27	23	100
April,	2,700	3	12	100
May,	3,100	4	53	100
June,	5,600	5	70	100
July,	8,000	4	125	100
August,	3,500	5	34	100
September,	19,400	4	129	100
October,	5,600	5	93	100
November,	15,600	19	110	100
December,	17,900	26	115	100
Average,	8,600	-	73	100
Total,	-	151	-	-

Effluent of Lawrence City Filter.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
January,	70	99.3	25	25	4.0	48.0
February,	55	99.2	24	24	12.5	38.0
March,	33	99.2	27	27	0.0	44.5
April,	20	99.3	4	4	0.0	25.0
May,	16	99.5	4	4	0.0	25.0
June,	22	99.6	5	5	0.0	60.0
July,	11	99.9	4	4	25.0	25.0
August,	14	99.6	5	5	40.0	0.0
September,	16	99.9	4	4	0.0	50.0
October,	26	99.5	5	5	0.0	20.0
November,	90	99.4	19	19	10.5	36.8
December,	75	99.6	25	25	4.0	28.0
Average,	37	99.5	-	-	8.0	33.4
Total,	-	-	151	151	-	-

Water from the Outlet of the Lawrence Reservoir.

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
January,	60	99.4	25	25	4.0	28.0
February,	60	99.2	24	24	4.0	50.0
March,	80	98.0	26	26	3.8	54.0
April,	48	98.2	4	4	0.0	25.0
May,	35	98.9	4	4	0.0	0.0
June,	29	99.5	5	5	0.0	0.0
July,	18	99.8	4	4	0.0	0.0
August,	23	99.4	5	5	20.0	0.0
September,	22	99.9	4	4	0.0	25.0
October,	60	98.9	5	5	0.0	0.0
November,	30	99.8	19	19	5.3	10.5
December,	37	99.8	26	26	0.0	42.0
Average,	42	99.2	-	-	3.1	19.5
Total,	-	-	151	151	-	-

Water from a Tap at Lawrence City Hall.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
January,	55	99.4	25	25	0.0	32.0
February,	36	99.5	24	24	8.3	38.0
March,	46	98.9	27	27	0.0	41.0
April,	57	97.9	4	4	0.0	0.0
May,	24	99.1	4	4	0.0	25.0
June,	44	99.2	5	5	0.0	0.0
July,	35	99.6	4	4	25.0	25.0
August,	135	96.2	4	4	0.0	0.0
September,	45	99.8	4	4	0.0	0.0
October,	60	98.9	5	5	0.0	20.0
November,	43	99.7	19	19	10.5	0.0
December,	65	99.6	26	26	0.0	23.0
Average,	55	99.0	-	-	3.6	17.0
Total,	-	-	151	151	-	-

Lawrence City Water from a Tap at the Experiment Station.

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
January,	45	99.5	26	26	0.0	30.8
February,	28	99.6	24	24	4.0	21.0
March,	28	99.3	27	27	0.0	52.0
April,	70	97.4	24	24	4.2	29.1
May,	30	99.0	25	25	0.0	28.0
June,	31	99.5	25	25	0.0	20.0
July,	18	99.8	25	25	8.0	12.0
August,	38	98.9	27	27	3.7	14.8
September,	24	99.9	25	25	0.0	20.0
October,	31	99.4	26	26	0.0	30.7
November,	31	99.8	25	25	0.0	8.0
December,	50	99.7	26	26	0.0	19.2
Average,	35	99.3	-	-	1.7	23.5
Total,	-	-	305	305	-	-

Sand Filtration with Addition of Copper Sulphate.

Filter No. 8A.

Filter No. 8A, $\frac{1}{200}$ of an acre in area, was first put into operation during 1893. During 1904, this filter contained about 30 inches in depth of sand of an effective size of 0.23 millimeter. The average rate of operation during the year has been 3,827,000 gallons per acre daily. The filter has been scraped eighteen times, and after scraping has been filled with filtered water from below. Beginning May 17, copper sulphate was introduced into the water applied to this filter, the proportion being 1 part of copper sulphate in 1,130,000 parts of water. This treatment was followed throughout the year, the proportion of copper sulphate increasing quite steadily, until at the end of the year the amount used was 1 part in 578,000 parts of water. A following table shows the amount used throughout each month of the year. Applying the copper sulphate in this way, it remained in the water above the sand for periods varying from five hours and one-quarter to a little more than eight hours, the difference being due to the differing rate of operation of the filter, this rate varying from 4,300,000 gallons per acre daily in May to 2,800,000 gallons per acre daily in December. Besides the preliminary period for germicidal action of copper sulphate in the water, while the water remained over the sand in the filter, there was an additional period, due to the time of passage of the water through the filter, about equal to the time that the water remained above the sand. Much copper was removed during filtration, however, as shown by a following table. Another table gives the rate of operation from month to month, and the time in hours and minutes of the storage of water above the filter sand.

During the year, determinations of the number of bacteria and B. coli in the water applied to and in the effluent from this filter were made. Determinations were made also during the months of September, October, November and December of the bacteria and B. coli in the water after passing to the filter, but before reaching the surface sand. Tables showing these results follow. Studying these tables, it will be noticed that the copper sulphate lessened the number of bacteria in the water to a considerable extent before reaching the surface sand of the filter, and that the B. coli were exterminated to some extent, 98 per cent. of the samples of the water before introduction of copper sulphate, and 86.8 per cent. of the samples of water taken from the tank, showing its presence.

Studying the tables showing the bacteria and B. coli in the effluent of this filter, it will be noticed that of the 1 cubic centimeter samples examined for B. coli, 26.4 per cent., and of the 100 cubic centimeter samples examined, 46.5 per cent., showed its presence, these figures being for only the period during which copper sulphate was added. These results show

a poorer B. coli efficiency during 1904 than during 1903, when copper sulphate was not used. During that year, B. coli was found in 12.6 per cent. of the 1 cubic centimeter samples and in 37.4 per cent. of the 100 cubic centimeter samples that were tested. The poorer efficiency when using copper sulphate was probably due to the destruction by this germicide of many of the bacteria in the sand which aid in the elimination of such bacteria as B. coli from the water. Tables showing all these results follow.

Canal Water. — Merrimack River Water.

[Parts per 100,000.]

1904.	Temperature. Degrees F.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
		Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.			
January, . .	37	V. slight.	.34	.0155	.0184	.0155	.368	.023	.0003	.55	88.4	1.7
February, .	33	V. slight.	.30	.0200	.0169	.0153	.371	.025	.0002	.56	84.3	1.4
March, . .	36	V. slight.	.35	.0098	.0164	.0136	.356	.016	.0002	.60	106.0	1.5
April, . .	44	V. slight.	.35	.0014	.0188	.0100	.193	.013	.0000	.41	95.8	–
May, . .	54	V. slight.	.51	.0077	.0161	.0145	.168	.013	.0000	.52	82.0	1.2
June, . .	67	V. slight.	.47	.0128	.0218	.0172	.260	.018	.0002	.44	75.0	1.5
July, . .	76	0.2	.48	.0080	.0212	.0160	.204	.019	.0004	.55	55.3	1.7
August, . .	74	0.1	.33	.0093	.0190	.0158	.401	.016	.0006	.42	61.0	1.8
September, .	63	0.1—	.48	.0136	.0219	.0189	.314	.022	.0009	.60	60.0	1.6
October, . .	57	0.1—	.39	.0108	.0162	.0152	.252	.019	.0004	.58	79.6	1.7
November, .	44	0.1—	.35	.0136	.0200	.0170	.284	.016	.0004	.46	–	1.7
December, .	35	0.3	.32	.0177	.0235	.0174	.365	.020	.0004	.67	–	1.8
Average, .	52	0.1	.39	.0117	.0192	.0155	.295	.018	.0003	.53	78.7	1.6

Effluent of Filter No. 8A.

[Parts per 100,000.]

1904.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature of Effluent.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
			Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
January, . .	3,192,400	35	0	.25	.0050	.0078	.390	.047	.0001	.41	54.8	1.5
February, .	3,049,000	34	0	.29	.0145	.0096	.395	.050	.0001	.49	47.3	1.6
March, . .	3,596,800	36	0	.35	.0004	.0072	.346	.032	.0000	.49	74.3	1.4
April, . .	3,975,500	–	–	–	–	–	–	–	–	–	73.5	–
May, . .	4,332,300	58	0	.35	.0004	.0104	.180	.021	.0000	.49	42.2	1.0
June, . .	4,071,300	66	0	.39	.0044	.0183	.263	.017	.0003	.51	42.2	1.5
July, . .	4,348,600	76	–	.33	.0008	.0106	.192	.029	.0000	.40	50.0	1.8
August, . .	4,067,000	74	0	.20	.0014	.0069	.408	.034	.0000	.31	28.0	1.8
September, .	4,681,000	65	0	.30	.0013	.0116	.338	.047	.0000	.46	50.6	1.6
October, . .	4,164,600	55	0	.34	.0012	.0096	.275	.030	.0000	.44	67.2	1.7
November, .	3,675,300	44	0	.32	.0050	.0116	.292	.025	.0000	.53	–	1.8
December, .	2,772,800	35	0	.25	.0163	.0127	.344	.030	.0009	.63	–	1.9
Average, .	3,827,200	53	0	.31	.0046	.0106	.311	.033	.0001	.47	53.0	1.6

Table showing Amount of Copper Sulphate applied to Water, and Time of Storage of Water above Sand in Filter No. 8A.

1904.	Actual Volume of Water Filtered Daily.	Copper Sulphate.		Rate (Gallons per Acre Daily).	Storage.	
		Parts per Million.	One Part in Parts of Water.		Hours.	Minutes.
May,	26,000	0.88	1,130,000	4,800,000	5	18
June,	20,400	1.11	900,000	4,100,000	5	34
July,	21,700	1.06	943,000	4,300,000	5	18
August,	20,800	1.17	855,000	4,100,000	5	34
September,	23,400	1.04	962,000	4,700,000	4	52
October,	20,800	1.15	870,000	4,200,000	5	26
November,	18,400	1.30	769,000	3,700,000	6	10
December,	13,900	1.73	578,000	2,800,000	8	8

	Inches.
Sand,	30
Underdrains,	6
Water above sand,	17

	Gallons.
Water above sand,	2,300
Water in sand,	2,000
Water in underdrains,	500
Water in tank,	4,800

Copper in Applied Water and Effluent of Filter No. 8A, as determined by Analyses.

Date	Source of Sample.	Copper. Grains per Gallon.	Copper. Parts per 100,000.	$CuSO_4+5H_2O$. Grains per Gallon.	$CuSO_4+5H_2O$. Parts per 100,000.	Quantity Examined (Liters).	Equivalent of $CuSO_4$.
							Mil.
Aug. 12,	Applied water,	.00257	.00440	.01007	.01727	25	1 part in 5.80
Sept. 16,	Applied water,	.01554	.02667	.06105	.10471	18	1 part in 0.96
Oct. 26,	Applied water,	.04923	.08444	.19327	.33151	18	1 part in 0.30
Nov. 9,	Applied water,	.02915	.05000	.11444	.19630	19	1 part in 0.51
Sept. 16,	Effluent,	.00356	.00611	.01399	.02399	18	1 part in 4.10
Oct. 26,	Effluent,	.00292	.00500	.01144	.01963	18	1 part in 5.10

Merrimack River Water applied to Experimental Filters.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Number of Samples tested for B. Coli.	Average Number of B. Coli per c.c.	Per Cent. of Samples containing B. Coli.
January,	3,800	18	36	100.0
February,	8,700	18	39	94.5
March,	3,500	15	13	100.0
April,	1,600	18	8	94.5
May,	2,600	23	21	100.0
June,	15,100	25	141	100.0
July,	4,400	25	102	100.0
August,	5,000	27	98	100.0
September,	13,800	24	121	100.0
October,	4,200	25	42	92.0
November,	7,800	24	67	96.0
December,	11,200	26	42	100.0
Average,	6,400	-	60	98.1
Total,	-	268	-	-

Applied Water containing Copper Sulphate.— Filter No. 8A.

September,	7,700	11	32	63.6
October,	2,300	12	14	83.5
November,	2,600	12	25	100.0
December,	2,300	10	37	100.0
Average,	3,700	-	27	86.8
Total,	-	45	-	-

Effluent of Filter No. 8A.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli.		Per Cent. of Samples containing B. Coli.	
			1 c.c.	100 c.c.	1 c.c.	100 c.c.
January,	80	98.0	-	-	-	-
February,	110	97.0	-	-	-	-
March,	150	95.7	-	-	-	-
April,	43	97.3	-	-	-	-
May,	47	98.2	13	13	15.4	46.2
June,	60	99.6	23	23	8.7	30.4
July,	30	99.3	24	24	12.5	66.7
August,	26	99.5	15	15	13.3	13.3
September,	160	98.0	11	11	18.2	45.4
October,	70	96.9	12	12	25.0	41.6
November,	140	94.6	12	12	58.3	58.3
December,	300	87.0	10	10	60.0	70.0
Average,	100	96.8	-	-	26.4	46.5
Total,	-	-	120	120	-	-

Rapid Filtration with Sulphate of Alumina as a Coagulant.

Filter No. 216.

In 1903, an experiment in filtering Merrimack River water at a high rate with the aid of sulphate of alumina as a coagulant was begun, the water after receiving the coagulant having a period of sedimentation before going to the filter. The filter used has been called Filter No. 216, and is a wooden tank 28 inches in diameter or approximately $\frac{1}{10000}$ of an acre in area, containing sand of an effective size of 0.60 millimeter. The filter was constructed as follows: About 1 inch above the bottom of the wooden tank was placed a perforated galvanized iron strainer held upon supports; above this was arranged 6 inches in depth of gravel underdrains, and above these underdrains 2.5 feet in depth of sand. Before coming to the filter, the water passed through a settling tank of such capacity that, when the filter was operating at a rate of 50,000,000 gallons per acre daily, about one hour's sedimentation was obtained. The coagulant is added as the water enters the settling basin.

During 1904, this filter was operated as a preliminary filter; that is, the water, after treatment with the coagulant, sedimentation and filtration through this filter, was passed to a plain sand filter. Filter No. 216 was operated at an average rate of 41,000,000 gallons per acre daily, the intention being to operate it as near 40,000,000 gallons per acre daily as possible. During a large part of the year, the amount of coagulant used averaged 1¼ grains per gallon of water filtered. The average bacterial efficiency by coagulation and filtration through Filter No. 216 during the year was 90.6 per cent. With greater care, finer sand in the filter, and the use of a somewhat larger amount of coagulant, etc., a much greater efficiency could have been obtained, as shown by the results given by the filter during 1903 and published in the report of the Board for that year. As stated, however, the object during 1904 was to use this filter as a preliminary filter or strainer, and to learn something in regard to its efficiency when run with a minimum amount of attention, such as it would receive in ordinary factory or mill work, and placing dependence for final bacterial efficiency upon a secondary filter. The following tables show the results of chemical and bacterial analyses of the effluent of this filter and of the water after coagulation and sedimentation before passing to the filter. The B. coli efficiency of the filter was much better, comparatively speaking, than its bacterial efficiency, B. coli being found in only 17.8 per cent. of the 1 cubic centimeter samples and in 16.6 per cent. of the 100 cubic centimeter samples examined.

Effluent of Filter No. 216.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
			Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
Average,	40,891,000	52	.07	.12	.0110	.0076	.30	.019	.0002	.20	83.0	0.8

Applied Water. — Filter No. 216.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Number of Samples tested for B. Coli.	Average Number of B. Coli per c.c.	Per Cent. of Samples containing B. Coli.
January,	1,900	18	7	66.7
February,	3,000	16	5	81.2
March,	2,400	10	1	80.0
April,	700	15	3	53.3
May,	600	17	11	100.0
June,	9,400	25	59	100.0
July,	3,400	24	170	100.0
August,	2,700	26	47	96.0
September,	8,100	25	13	96.0
October,	2,600	26	24	96.0
November,	4,900	25	16	100.0
December,	6,700	26	24	96.0
Average,	3,900	-	32	84.6
Total,	-	253	-	-

Filter No. 216. — Table showing Removal of Bacteria by Sedimentation, Filtration and Total Removal.

1904.	Average Number of Bacteria in			Per Cent. of Bacteria removed by —		
	Canal Water.	Water applied to Filter No. 216.	Effluent of Filter No. 216.	Coagulation and Sedimentation.	The Filter.	The System.
January,	3,800	1,900	155	50.0	92.0	95.9
February,	3,700	3,000	550	18.9	81.6	85.3
March,	3,500	2,400	350	31.4	85.4	90.0
April,	1,600	700	180	56.2	74.3	88.8
May,	2,600	600	425	77.0	28.1	83.7
June,	15,100	9,400	1,400	37.7	85.1	90.7
July,	4,400	3,400	195	22.7	94.3	95.5
August,	5,000	2,700	170	46.0	93.8	96.6
September,	13,800	8,100	850	41.4	89.4	93.9
October,	4,200	2,600	450	38.0	82.7	89.3
November,	7,800	4,900	1,100	37.2	77.5	85.9
December,	11,200	6,700	1,300	40.2	80.6	88.4
Average,	6,400	3,900	600	39.0	84.6	90.6

Effluent of Filter No. 216.

[Average of Bacterial Analyses.]

Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli.		Per Cent. of Samples containing B. Coli.	
		1 c.c.	100 c.c.	1 c.c.	100 c.c.
600	84.6	253	253	17.8	16.6

Sulphate of Alumina as a Germicide.

In this connection, experiments were made to show the germicidal effect of sulphate of alumina, and results of one experiment are shown in a following table. In this experiment, five separate volumes of water were taken. To the first, no sulphate of alumina was added; to the second, 0.5 grain; to the third, 1 grain; to the fourth, 1.5 grains and to the fifth, 2 grains. Bacterial determinations of the numbers of bacteria present in the entire sample and in the supernatant water only were made daily. Determinations of B. coli in the entire sample and in the supernatant water only were also made. Studying the tables, it will be seen that the effect of sulphate of alumina as a germicide is plainly shown, especially with the higher amounts taken, and more clearly by its effect upon B. coli than upon the total number of bacteria present.

Table showing Germicidal Effect of Sulphate of Alumina.

Bacteria per Cubic Centimeter. — Entire Sample.

Elapsed Time.	Sulphate of Alumina, in Grains per Gallon.				
	0.	0.5.	1.0.	1.5.	2.0.
Start,	1,450	1,450	1,450	1,450	1,450
1 day,	176,400	4,900	3,200	800	1,900
2 days,	321,950	550	290	110	125
3 days,	430,000	11,200	11,400	1,050	155
5 days,	129,000	25,800	4,600	1,700	260
7 days,	7,700	3,200	40,000	5,900	75,600
9 days,	15,000	1,600	26,300	300	255
11 days,	16,500	18,500	30,500	41,400	28,200

Bacteria per Cubic Centimeter. — Supernatant Water Only.

Elapsed Time.	0.	0.5.	1.0.	1.5.	2.0.
Start,	1,450	1,450	1,450	1,450	1,450
1 day,	21,500	2,150	1,600	1,150	2,000
2 days,	35,000	370	900	33	165
3 days,	57,000	5,000	21,250	3,300	22
5 days,	24,000	3,600	35,850	7,900	650
7 days,	3,000	3,000	37,800	7,700	600
9 days,	2,200	1,000	1,500	11,500	5
11 days,	2,600	1,750	3,250	1,100	4,500

Table showing Germicidal Effect of Sulphate of Alumina — Concluded.

B. Coli per Cubic Centimeter. — Entire Sample.

Elapsed Time.	Sulphate of Alumina, in Grains per Gallon. 0.	0.5.	1.0.	1.5.	2.0.
Start,	36	1	-	-	-
1 day,	6	0	0	0	0
2 days,	95	11	20	0	25
3 days,	65	1	16	0	0
5 days,	20	0	0	22	0
7 days,	25	0	0	0	0
9 days,	11	35	68	40	114
11 days,	0	0	0	21	0

B. Coli per Cubic Centimeter. — Supernatant Water Only.

Elapsed Time.	0.	0.5.	1.0.	1.5.	2.0.
Start,	-	-	-	-	-
1 day,	23	0	1	3	0
2 days,	15	0	2	4	2
3 days,	16	0	1	1	1
5 days,	0	0	1	0	0
7 days,	2	1	0	0	0
9 days,	4	4	1	0	0
11 days,	0	4	2	0	0

Growth of Bacteria in Filtered Water.

Various experiments have been made to determine the rapidity of growth of bacteria in the effluents of filters operating by different methods. The results of two of these experiments follow, and show clearly the exceedingly rapid growth of bacteria in the effluent of Filter No. 8 A, receiving copper sulphate, as compared with the rapidity of growth in the effluent from plain sand filtration (Filter No. 220), and filtration with the aid of aluminum sulphate as a coagulant (Filter No. 216).

Table showing the Change on Standing in the Bacterial Contents of the Effluents of Mechanical Filter No 216, Slow Sand Filter No. 220 and Filter No 8A, purifying Copper-treated Water.

Elapsed Time.	Experiment No. 160, started May 19, 1904. Effluent of Filter — No. 8A.	No. 216.	No. 220.	Experiment No. 162, started May 31, 1904. Effluent of Filter — No. 8A.	No. 216.	No. 220.
Start,	148	142	5	3	55	10
1 day,	35,000	70	370	416	16	4
2 days,	31,100	38	3,100	3,900	5	8
3 days,	24,200	82	1,098	26,700	11	27
4 days,	-	-	-	26,000	14	25
5 days,	15,500	26	2,000	-	-	-
6 days,	-	-	-	15,600	200	23
7 days,	9,800	25	300	-	-	-
8 days,	-	-	-	1,500	60	12
10 days,	-	-	-	400	37	11
13 days,	-	-	-	10,300	180	7

Double Filtration. — Filter No. 243 (Supplementary to Filter No. 216).

This filter, $\frac{1}{20000}$ of an acre in area, and containing $2\frac{1}{2}$ feet in depth of sand of an effective size of 0.26 millimeter, was put into operation early in 1904, and after a preliminary period of operation with river water, in order to coat the sand grains with organic matter, bacteria, etc., — the period of so-called biological construction, — began to be operated with the effluent of Filter No. 216, and at an average rate of 6,176,000 gallons per acre daily. Tables giving the results of the chemical and bacterial analyses follow. The effluent of Filter No. 216 contained, during a period from June 15 to December 31, throughout which its effluent was applied to Filter No. 243, 677 bacteria per cubic centimeter, and the effluent of Filter No. 243 contained 50 bacteria per cubic centimeter, a reduction of 74 per cent. Removal of B. coli was little improved by Filter No. 243 above that by Filter No. 216.

Effluent of Filter No. 243.

[Parts per 100,000.]

1904.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
			Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
July,	4 803,300	74	0	.18	.0006	.0090	.18	.020	.0000	.24	61.6	0.9
August,	4,475,600	73	0	.16	.0030	.0088	.39	.025	.0000	.26	56.0	1.1
September,	7,417,900	65	0.1—	.15	.0010	.0100	.35	.081	.0000	.23	52.2	1.0
October,	6,089,000	56	0	.20	.0058	.0081	.26	.025	.0900	.43	73.2	1.8
November,	7,065,500	44	0.1—	.22	.0110	.0102	.32	.019	.0000	.38	93.2	0.9
December,	7,707,000	36	0.1—	.14	.0166	.0117	.35	.025	.0000	.47	-	1.5
Average,	6,176,383	58	-	.17	.0063	.0095	.31	.024	.0000	.33	67.2	1.1

Effluent of Filter No. 243.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli.		Per Cent. of Samples containing B. Coli.	
			1 c.c.	100 c.c.	1 c.c.	100 c.c.
July,	34	82.6	23	23	30.4	39.0
August,	70	59.0	26	26	11.5	11.5
September,	33	96.1	25	25	12.0	24.0
October,	60	86.4	26	26	11.5	15.4
November,	55	95.0	25	25	0.0	0.0
December,	50	96.1	26	26	3.8	3.8
Average,	50	85.9	-	-	11.5	15.6
Total,	-	-	151	151	-	-

Filters Nos. 218, 219 and 220.

In July, 1903, these three filters were put into operation for the purpose of studying the chemical and bacterial quality of the effluents resulting from filtering waters of three different degrees of pollution. It is also in part an experiment in double filtration, as Filter No. 218 received from March 1 until the end of the year the effluent of the Lawrence city filter. Filters Nos. 218, 219 are each $\frac{1}{10000}$ of an acre in area, and Filter No. 220 is $\frac{1}{5000}$ of an acre in area. Each filter contains $4\frac{1}{2}$ feet in depth of sand of an effective size of 0.20 millimeter. Filter No. 218 received the effluent of the Lawrence city filter, Filter No. 219 received river water to which a certain small percentage of sewage was added, and Filter No. 220 river water. Following tables show the average results of the chemical and bacterial analyses made during the year of the water applied to and of the effluents from these filters. It will be noticed that the effluent of Filter No. 218, to which city water was applied at a rate of 2,500,000 gallons per acre daily, contained on an average only 6 bacteria per cubic centimeter; that the bacterial efficiency of the filter was 75.9 per cent.; that none of the 1 cubic centimeter samples of the effluent examined contained B. coli, and only 3.3 per cent. of the 100 cubic centimeter samples of the effluent examined contained this germ.

Filter No. 220, receiving the river water, had in its effluent 47 bacteria per cubic centimeter, removing 98.9 per cent. of the bacteria in the applied water. B. coli was found in 15.1 per cent. of the 1 cubic centimeter samples of effluent examined, and 34.2 per cent. of the 100 cubic centimeter samples.

The effluent of Filter No. 219, receiving the most polluted water of the three, namely, river water to which sewage was added, had 112 bacteria per cubic centimeter in its effluent, a removal of 99.5 per cent., the number in the applied water being 49,670 per cubic centimeter. B. coli was found in 47 per cent. of 1 cubic centimeter samples, and 66.4 per cent. of the 100 cubic centimeter samples of its effluent.

Each of the filters was operated at a rate approximating 2,500,000 gallons per acre daily. The exceedingly good character of the effluent of Filter No. 218 from a chemical point of view is noteworthy. Tables showing these results follow.

Effluent of Filter No. 218.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
Average,	2,496,720	58	0	.23	.0006	.0063	.30	.041	.0003	.29	63.8	2.1

Effluent of Filter No. 218.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
March,	6	80.0	-	-	-	-
April,	10	88.4	-	-	-	-
May,	7	65.0	-	-	-	-
June,	9	59.0	-	-	-	-
July,	10	41.0	-	-	-	-
August,	5	78.2	13	13	0.0	0.0
September,	4	83.4	13	13	0.0	0.0
October,	5	85.5	13	13	0.0	0.0
November,	8	90.0	12	12	0.0	0.0
December,	5	88.7	12	12	0.0	16.7
Average,	6	75.9	-	-	0.0	3.3
Total,	-	-	63	63	-	-

Applied Water. — Filter No 219.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
Average,	-	54	0.2	.41	.0475	.0296	.0211	.39	.020	.0005	.57	76.4	1.7

Effluent of Filter No. 219.

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
Average,	2,360,200	55	0	.30	.0027	.0103	-	.35	.088	.0010	.43	30.3	1.6

Applied Water. — Filter No. 219.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Number of Samples tested for B. Coli.	Average Number of B. Coli per c.c.	Per Cent. of Samples containing B. Coli.
March,	42,000	-	-	-
April,	27,500	-	-	-
May,	71,400	-	-	-
June,	163,900	-	-	-
July,	37,600	-	-	-
August,	31,800	11	1,223	91.0
September,	18,000	8	469	87.5
October,	29,500	12	546	92.0
November,	51,000	7	1,217	86.0
December,	14,000	1	33	100.0
Average,	48,670	-	698	91.3
Total,	-	39	-	-

Effluent of Filter No. 219.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
March,	120	99.7	-	-	-	-
April,	28	99.9	-	-	-	-
May,	41	99.9	-	-	-	-
June,	140	99.9	-	-	-	-
July,	65	99.8	-	-	-	-
August,	51	99.8	11	11	54.5	54.5
September,	120	99.3	8	8	62.5	75.0
October,	20	99.9	12	12	8.3	50.0
November,	210	99.6	7	7	43.0	86.0
December,	325	97.1	3	3	66.7	66.7
Average,	112	99.5	-	-	47.0	66.4
Total,	-	-	41	41	-	-

Effluent of Filter No. 220.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
Average,	2,391,200	54	0	.31	.0032	.0103	.30	.028	.0002	.43	41.2	1.7

Effluent of Filter No. 220.

[Average of Bacterial Analyses.]

1904.	Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli. 1 c.c.	Number of Samples tested for B. Coli. 100 c.c.	Per Cent. of Samples containing B. Coli. 1 c.c.	Per Cent. of Samples containing B. Coli. 100 c.c.
January,	40	99.0	-	-	-	-
February,	37	99.0	-	-	-	-
March,	40	99.0	-	-	-	-
April,	28	98.8	-	-	-	-
May,	51	98.0	-	-	-	-
June,	12	99.9	-	-	-	-
July,	24	98.9	-	-	-	-
August,	26	99.5	13	13	15.4	0.0
September,	51	99.6	12	12	16.7	33.3
October,	11	99.8	13	13	0.0	30.8
November,	46	99.4	10	10	10.0	40.0
December,	200	97.0	6	6	33.3	66.7
Average,	47	98.9	-	-	15.1	34.2
Total,	-	-	54	54	-	-

Filters Nos. 245 and 246.

These two filters are each $\frac{1}{20000}$ of an acre in area, and were put into operation in April, 1904, the object of the experiment being to study filtration through sand, comparing it with filtration through sand upon which was a layer of coke. Filter No. 245 contained 4 feet in depth of sand of an effective size of 0.30 millimeter, and Filter No. 246 3 feet 8 inches in depth of sand of the same effective size, on which were 4 inches of coke breeze from which the dust had been removed, making the grains of coke approximately the same size as the sand grains. The rate of operation of these filters was slightly more than 6,000,000 gallons per acre daily. Tables showing the chemical and bacterial analyses of their effluents follow. Little difference in the character of these effluents can be noted; if anything, the sand filter proved the more efficient. The only difference in operation was that Filter No. 246 containing the coke was operated for nearly five months before surface treatment became necessary. After this, however, removal of the coke from the surface had to be made five times before the end of the year. The sand filter was scraped seven times during this period.

Effluent of Filter No. 245.

[Parts per 100 000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
			Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
Average,	6,295,200	59	0	.32	.0045	.0113	.29	.026	.0004	.48	45.4	1.7

Effluent of Filter No. 245.

[Average of Bacterial Analyses.]

Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli.		Per Cent. of Samples containing B. Coli.	
		1 c.c.	100 c.c.	1 c.c.	100 c.c.
300	87.8	127	125	25.7	49.9

Effluent of Filter No. 246.

[Parts per 100,000.]

1904.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Hardness.
			Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
Average,	6,164,100	59	0	.32	.0042	.0111	.27	.024	.0007	.48	41.8	1.7

Effluent of Filter No. 246.

[Average of Bacterial Analyses.]

Average Number of Bacteria per c.c.	Per Cent. removed (Efficiency).	Number of Samples tested for B. Coli.		Per Cent. of Samples containing B. Coli.	
		1 c.c.	100 c.c.	1 c.c.	100 c.c.
430	95.9	130	128	32.2	48.5

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The work of food and drug inspection, which has been conducted continuously by the Board since 1883, has undoubtedly secured to the people of the State a degree of protection from fraudulent and harmful adulteration which, as measured by an economic standard, is greatly in excess of the cost of administering the laws providing for this important work.

The scope of these laws is fully set forth in the report of the Board for the year 1903.

In the accompanying report of the analyst will be found a detailed account of the examination of samples of food and drugs purchased by the inspectors during the year.

The Board is required, under the provisions of the statutes, to report annually to the General Court the number of prosecutions made, and an itemized account of the money expended in carrying out the provisions of the law. (Chapter 75, section 7, Revised Laws.) This report has been made annually to the General Court in January since 1884.

A general summary of the work of the Board in this direction is also presented in the annual report of each year.

In addition to the foregoing, the Board is required by a recent statute (Acts of 1902, chapter 272) to publish as often "as once each month in the official publication of the board, . . . a certificate of the examination or analysis made by authority of the board during the preceding month of any article of food manufactured or offered for sale in the Commonwealth, which is adulterated within the meaning of chapter seventy-five of the Revised Laws; and the board shall also cause to be published, with such certificate of examination, a statement of the trade-mark, brand-mark, or name, with the name and place of business of the manufacturer, which appear upon the package or box containing such adulterated article, or with the name and place of business of the wholesale dealer of whom the goods were obtained."

The official publication referred to in the foregoing statute is the weekly bulletin of the Board, which has been published continuously during the past twenty years, and distributed principally to the health authorities of the cities and towns.

The recent law of 1902 (chapter 230) authorizes the Board "to publish for general distribution such parts of its annual report, and such other matter as it may deem adapted to promote the interests of the public in this Commonwealth." Under this provision, that portion of the report

relating to food and drug inspection has since been published and distributed in pamphlet form.

The following lists contain the names of cities and towns to which warning notices of sales of adulterated food and drugs were sent in 1904, with the number of such sales in each instance: —

Cities and Towns to which Notices were sent on Account of Adulterated Milk in 1904.

Attleborough,	6	Natick,	2
Beverly,	3	New Bedford,	7
Boston,	3	Newburyport,	2
Brockton,	14	Newton,	12
Brookline,	2	North Adams,	1
Cambridge,	28	Paxton,	2
Chelsea,	21	Pittsfield,	7
Dover,	3	Plymouth,	4
Everett,	8	Provincetown,	7
Fall River,	16	Revere,	6
Fitchburg,	14	Salem,	8
Framingham,	2	Salisbury,	3
Gloucester,	33	Shrewsbury,	2
Haverhill,	5	Somerville,	10
Holliston,	1	Stoughton,	2
Holyoke,	8	Swansea,	3
Hyde Park,	1	Taunton,	1
Lawrence,	8	Waltham,	9
Lowell,	57	Wareham,	2
Malden,	3	Watertown,	6
Marblehead,	1	Wayland,	1
Marlborough,	1	Westfield,	1
Marshfield,	1	Winthrop,	2
Medford,	6	Woburn,	6
Medway,	1	Worcester,	28
Milford,	4		
Nantucket,	1	Total,	380

Cities and Towns to which Notices were sent on Account of Adulterated Articles of Food Other than Milk.

Arlington,	1	Gloucester,	3
Attleborough,	1	Holyoke,	1
Beverly,	1	Lawrence,	11
Boston,	44	Lowell,	9
Brookline,	1	Lynn,	1
Cambridge,	12	Malden,	2
Chelsea,	1	Medford,	3
Fall River,	2	Natick,	2

Cities and Towns to which Notices were sent on Account of Adulterated Articles of Food Other than Milk — Concluded.

New Bedford,	1	Walpole,	1
Newburyport,	4	Waltham,	1
Pittsfield,	7	Wareham,	1
Quincy,	1	Wilmington,	1
Reading,	1	Winthrop,	1
Revere,	1	Woburn,	2
Rockland,	1	Worcester,	1
Salisbury,	1		
Somerville,	9	Total,	132
Springfield,	3		

Cities and Towns to which Notices were sent on Account of Adulterated Drugs.

Andover,	2	Nantucket,	1
Boston,	34	Natick,	1
Braintree,	1	Newburyport,	1
Cambridge,	4	North Adams,	1
Chelsea,	2	Northampton,	1
Everett,	1	Palmer,	2
Fall River,	4	Pittsfield,	5
Gardner,	1	Provincetown,	1
Gloucester,	1	Reading,	1
Holyoke,	1	Rockland,	2
Lawrence,	5	Somerville,	5
Lowell,	1	Waltham,	1
Malden,	4	Woburn,	3
Marblehead,	1		
Marlborough,	1	Total,	88

The following report treats of the operations of the Board under the provisions of the food and drug acts during the year ended Sept. 30, 1904. The report made to the Legislature in January, 1905, "of the number of prosecutions made under the act and an itemized account of the money expended in carrying out the provisions thereof," is also embodied in this annual report.

The following persons comprised the force employed by the Board during the year in this department: —

Albert E. Leach,	*Analyst.*
Charles A. Goessmann,	*Analyst.*
Hermann C. Lythgoe,	*Assistant Analyst.*
John F. McCaffrey,	*Inspector.*
John H. Terry,	*Inspector.*
Horace F. Davis,	*Inspector.*

The number of samples of food and drugs examined during the year is shown in the accompanying table, together with a summary of the work done since the beginning of this line of work in 1883: —

FOOD AND DRUG INSPECTION (1883–1904).

SUMMARY.	YEARS.	
	1904.	Total 1883-1904.
Number of samples of milk examined,	4,997	87,304
Number of samples above standard,	3,307	55,593
Number of samples below standard,	1,690	31,711
Percentage of adulteration,	33.8	36.3
Number of samples of other kinds of food examined (not milk),	2,799	54,809
Number of samples of good quality,	2,521	44,869
Number of samples adulterated, as defined by the statutes,	278	9,940
Percentage of adulteration,	9.9	18.1
Number of samples of drugs examined,	855	15,243
Number of samples of good quality,	526	9,308
Number of samples adulterated, as defined by the statutes,	329	5,935
Percentage of adulteration,	38.5	38.9
Total examinations of food and drugs,	8,651	157,356
Total examinations of good quality,	6,354	109,770
Total examinations not conforming to the statutes,	2,297	47,586
Percentage of adulteration,	26.6	30.2
Expense of collection, examination and prosecution,	$12,069 11	$220,770 06
Expense of collection, examination and prosecution, per sample,	1 40	1 40

It appears from the foregoing table that 8,651 samples of food and drugs were collected and examined during the year ended Sept. 30, 1904, of which number 2,297, or 26.6 per cent., were found to be adulterated, or not up to the standard required by the statutes. This large ratio, however, does not represent the actual proportion of adulteration which actually exists in the general food supply. On the contrary, it far exceeds it, since the articles collected for examination are chiefly those which experience has shown to be specially liable to adulteration.

The whole number of samples of food and drugs examined since the beginning of work in 1883 was 157,356, of which 87,304, or more than one-half, as required by the statutes, were samples of milk.

The amount expended in the enforcement of the food and drug acts since the beginning of work has been $220,770.06, and the expense per sample $1.40 for the whole time. This expense was reduced from $2.26 per sample in 1883 to $1.40 in 1904.

The total amount of fines imposed for violation of the acts relating to food and drug inspection, up to Sept. 30, 1904, was $42,428.48.

Prosecutions.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of work in 1883 (Revised Laws, chapter 75, sections 16 to 27)*: —

Number of Complaints entered in Court.

Year.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1883,	–	5	4	9	8	–†
1884,	2	1	45	48	44	–†
1885,‡	50	1	68	119	103	–†
1886,§	10	–	10	20	19	–†
1887,	30	–	34	64	60	–†
1888,	22	–	43	65	61	$2,042 00
1889,	74	–	66	140	124	3,889 00
1890,	78	–	24	102	96	3,919 00
1891,	96	5	49	150	135	2,668 00
1892,	52	12	72	136	123	3,661 70
1893,	26	3	67	96	92	2,476 00
1894,	14	–	76	90	77	2,625 00
1895,	13	11	68	92	86	2,895 30
1896,	7	–	68	75	74	2,812 20
1897,	13	1	51	65	64	2,756 60
1898,	10	–	54	64	62	2,060 98
1899,	19	2	26	47	45	1,432 66
1900,	45	5	44	94	89	1,890 70
1901,	30	–	65	95	90	1,874 70
1902,	25	3	48	76	74	2,617 98
1903,	34	1	44	79	70	1,297 66
1904,	6	6	50	62	57	1,509 00
	656	56	1,076	1,788	1,653	$42,428 48

Ratio of convictions to complaints, 92.4 per cent.

Note — All complaints entered before May 1, 1886, were under the direction of the Board of Health, Lunacy and Charity, and all after that date were under the direction of the State Board of Health.

The number of prosecutions made against offenders during the year was 62, and the number of convictions 57.

The following report was transmitted to the Legislature Jan. 21, 1905, in compliance with the terms of the statute, section 7, chapter 75, Revised Laws: —

Office of the State Board of Health,
State House, Boston, Jan. 21, 1905.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts.

Section 7 of chapter 75 of the Revised Laws of Massachusetts provides that the State Board of Health "shall annually report to the general court

* These sections have been published, together with all the other statutes relating to food and drug inspection, in a pamphlet authorized by chapter 280 of the Acts of 1902.

† No record kept. ‡ To May 1, 1886. § Four months only.

the number of prosecutions made under the provisions of sections sixteen to twenty-seven, inclusive, and an itemized account of the money expended in carrying out the provisions thereof;" and in accordance with this provision the following report is made.

The number of prosecutions entered during the twelve months ending Sept. 30, 1904, was 62. One of the defendants left the State, pending a hearing; 1 was acquitted; 3 were discharged on motion of the prosecution, new complaints being entered against those more directly responsible; and the remainder (57) were convicted.

The following table sets forth the nature of the offence complained of, the place where the offence was committed, the date of trial and the result in each case: —

FOR SALE OF MILK NOT OF GOOD STANDARD QUALITY.

Place.	Date.	Result.
Lowell,	Oct. 14, 1903,	Conviction.
Spencer,	Oct. 21, 1903,	Conviction.
Salem,	Oct. 27, 1903,	Conviction.
Salem,	Nov. 3, 1903,	Conviction.
Salem,	Nov. 3, 1903,	*Nol pros.*
Brockton,	Nov. 5, 1903,	Conviction.
Lowell,	Nov. 28, 1903,	Conviction.
Whitman,	Dec. 16, 1903,	Conviction.
Needham,	Dec. 21, 1903,	Conviction.
Watertown,	March 12, 1904,	Conviction.
Dover,	April 27, 1904,	Conviction.
Sudbury,	April 28, 1904,	Conviction.
Sudbury,	April 28, 1904,	Conviction.
East Brookfield,	April 29, 1904,	Conviction.
Boylston,	May 3, 1904,	Conviction.
Millis,	May 24, 1904,	Conviction.
Medway,	May 24, 1904,	Conviction.
Medway,	May 24, 1904,	Conviction.
Medway,	May 24, 1904,	Conviction.
North Brookfield,	May 26, 1904,	Conviction.
New Braintree,	May 26, 1904,	Conviction.
Hampden,	May 26, 1904,	Conviction.
Hingham,	May 27, 1904,	Conviction.
Hingham,	May 27, 1904,	Conviction.
Woburn,	June 4, 1904,	Conviction.
Nantucket,	July 7, 1904,	Acquittal.
Holden,	July 28, 1904,	Conviction.
Holliston,	Aug. 6, 1904,	Conviction.
Medway,	Aug. 13, 1904,	Conviction.
Medway,	Aug. 13, 1904,	Conviction.
Carlisle,	Aug. 20, 1904,	Conviction.
Lowell,	Aug. 31, 1904,	Conviction.

Place.	Date.	Result.
Lowell,	Aug. 31, 1904,	Conviction.
Lowell,	Aug. 31, 1904,	Conviction.
Lowell,	Aug. 31, 1904,	Conviction.
South Framingham,	Sept. 3, 1904,	Conviction.
Carlisle,	Sept. 14, 1904,	Conviction.
Lowell,	Sept. 15, 1904,	Conviction.
Brookfield,	Sept. 15, 1904,	Defendant left State.
Reading,	Sept. 20, 1904,	Conviction.
Reading,	Sept. 20, 1904,	Conviction.
Salisbury,	Sept. 28, 1904,	Conviction.

For Sale of Milk containing Coloring Matter.

Salem,	Oct. 27, 1903,	Conviction.
Salem,	Nov. 3, 1903,	Conviction.
Salem,	Nov. 3, 1903,	*Nol pros.*
Gloucester,	Dec. 9, 1903,	Conviction.
Lowell,	Aug. 31, 1904,	Conviction.

For Sale of Milk containing Formaldehyde.

Lowell,	Aug. 31, 1904,	Conviction.

For dealing in Milk, Wagon bearing no Name.

Lowell,	Aug. 31, 1904,	Conviction.
Lowell,	Aug. 31, 1904,	Conviction.

For Sale of Adulterated Cheese.

Boston,	Oct. 2, 1903,	Conviction.
Boston,	Oct. 2, 1903,	Conviction.

For Sale of Adulterated Foods Other than Milk and Milk Products.

Article.	Place.	Date.	Result.
Raspberry jam,	Lowell,	Oct. 6, 1903,	Conviction.
Meat,	Boston,	March 15, 1904,	Conviction.
Cream of tartar,	Springfield,	June 17, 1904,	Conviction.
Maple sugar,	Lowell,	June 30, 1904,	Conviction.

For Sale of Adulterated Drugs.

Phenacetine,	Boston,	Oct. 30, 1903,	Conviction.
Tincture of iodine,	Newburyport,	Oct. 31, 1903,	Conviction.
Distilled water,	Newburyport,	Oct. 31, 1903,	Conviction.
Phenacetine,	Boston,	Nov. 24, 1903,	Conviction.
Tincture of iodine,	Boston,	Dec. 18, 1903,	*Nol pros.*
Phenacetine,	Boston,	Jan. 6, 1904,	Conviction.

The amount paid in fines was $1,509.

The expenditures for the year were as follows: —

Salaries of analysts,	$5,000 00
Salaries of inspectors,	4,280 00
Travelling expenses and purchase of samples,	1,935 13
Apparatus and chemicals,	452 68
Printing,	39 02
Services (cleaning laboratory),	106 00
Express and postage,	10 33
Sundry laboratory supplies,	98 25
Books and maps,	97 30
Extra services (stenographer),	29 15
Typewriting supplies,	21 25
Total,	$12,069 11

REPORT OF THE ANALYST.

By Albert E. Leach.

REPORT OF THE ANALYST.

By Albert E. Leach.

Dr. Charles Harrington, *Secretary State Board of Health.*

Dear Sir: — I herewith submit my report on the analysis of food and drugs for the year ending Sept. 30, 1904.

In the past reports, especially from 1899 on, methods of analysis of various foods examined by this department have been outlined whenever these methods are in any way peculiar to this laboratory. It should again be stated that the percentage of adulteration of the various foods and drugs as given in the statistics which follow is far higher than that of the foods as they exist on the market. This is true because in most cases only such varieties of food as are found by experience most liable to adulteration are examined; and, again, the samples of these foods collected by the inspector are in many cases of suspicious character as regards purity, discrimination being exercised in this regard by the inspector.

While in most cases usage or experience suggests the forms of adulteration peculiar to various foods, the analyst has to be on the lookout to meet new conditions constantly arising. His methods are largely qualitative, since technically he need only show, in most cases, the mere presence of a forbidden ingredient.

As a rule, a full analysis of adulterated food, beyond establishing the nature and in some instances the amount of the adulteration, is entirely unnecessary.

On account of the necessity of verifying such formulas as, under the law, must be placed on certain compound articles of food, it is frequently necessary to make quantitative determinations. When such quantitative results are calculated from assumed or variable factors, which is necessary when the adulterant or substance is itself complex or variable in composition, as, for example, in the case of commercial glucose, the analyst is always conservative in his figures, by expressing the minimum amount of the adulterant, so as to give the defendant the benefit of any doubt. The same is true where the result of the judgment is based on the appearance of the food under the microscope.

These cases should, however, be distinguished from those in which fixed and definite standards are specified by statute, as, for example, in the case of total solids or fat in milk, or acidity in vinegar. Here there is, of course, great necessity for precision in quantitative work.

Milk.

There were 4,691 samples of milk examined, of which 1,627, or 34.7 per cent. were below the standard. This high ratio of adulteration is presumably much greater than the actual conditions prevailing throughout the State, since with milk, more than in the case of other foods, the samples collected are very frequently from suspected sources.

The following tables show in summarized form the localities from which milk has been collected during the year, as well as the general quality of the milk: —

Milk from Cities.

Cities.	Number above Standard.	Number below Standard.	Total Samples collected.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with — Annatto.	Aniline Orange.	Caramel.	Number of Samples preserved with Formaldehyde.
Boston,	217	68	285	24.8	10.08	-	-	-	-	-
Brockton,	49	37	86	43.0	10.73	1	-	-	-	-
Cambridge,	132	68	200	34.0	11.00	-	-	-	-	-
Chelsea,	113	90	203	44.3	10.45	-	-	-	-	-
Everett,	26	24	50	48.0	11.27	-	-	-	-	-
Fall River,	87	42	129	32.5	9.40	-	-	-	-	5
Fitchburg,	43	19	62	31.7	8.47	4	-	-	-	-
Gloucester,	120	92	212	43.4	8.40	-	13	-	-	1
Haverhill,	39	21	60	35.0	9.53	1	-	-	-	-
Lawrence,	19	5	24	20.8	10.87	-	-	-	-	-
Lowell,	153	128	281	45.6	8.38	-	-	5	1	3
Malden,	39	41	80	50.1	11.00	-	-	-	-	-
Marlborough,	59	12	71	16.9	11.84	-	-	-	-	-
Medford,	32	15	47	32.0	11.52	-	-	-	-	-
North Adams,	10	11	21	52.4	11.16	-	-	-	-	-
New Bedford,	17	13	30	43.3	10.46	-	-	-	-	-
Newburyport,	89	16	105	15.2	11.20	-	-	-	-	-
Newton,	69	55	124	44.4	10.12	-	-	-	-	2
Pittsfield,	33	10	43	23.2	11.11	-	-	-	-	1
Quincy,	35	5	40	12.5	11.20	-	-	-	-	-
Salem,	88	28	116	24.1	9.67	-	-	-	-	1
Somerville,	92	72	164	45.8	10.80	-	-	-	-	-
Taunton,	66	5	71	7.6	10.10	1	-	-	-	-
Waltham,	128	45	173	26.0	10.05	-	-	-	-	-
Woburn,	6	19	25	76.0	9.93	-	-	-	-	-
Worcester,	187	108	295	36.6	8.90	4	-	-	-	-
Summary,	1,948	1,049	2,997	35.0	8.38	11	13	5	1	13

Milk from Towns.

Towns.	Number above Standard.	Number below Standard.	Total Samples collected.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with Aniline Orange.	Number of Samples preserved with Formaldehyde.
Adams,	11	1	12	8.3	12.97	-	-	-
Andover,	7	8	15	53.4	12.66	-	-	-
Attleborough,	91	36	127	38.4	10.00	2	-	-
Bedford,	17	3	20	15.0	11.34	-	-	-
Beverly,	14	2	16	12.5	10.92	-	-	1
Brookline,	98	30	128	23.4	11.49	-	-	-
Clinton,	9	1	10	10.0	9.86	1	-	-
Cottage City,	16	1	17	5.9	11.84	-	-	-
Dedham,	33	7	40	17.5	11.75	-	-	-
Greenfield,	15	-	15	0.0	10.04*	1	-	-
Hyde Park,	59	19	78	38.0	11.20	-	-	-
Marblehead,	13	4	17	23.5	11.60	-	-	1
Milford,	87	22	109	20.1	10.20	1	-	-
Nantucket,	15	-	15	0.0	12.00	-	-	-
Natick,	84	10	94	10.6	9.40	7	-	-
Palmer,	3	7	10	70.0	11.31	-	-	-
Plymouth,	20	3	23	13.0	12.40	-	-	-
Provincetown,	38	2	40	5.0	11.50	-	-	-
Reading,	4	6	10	60.0	10.60	-	-	-
Revere,	48	59	107	55.1	10.86	-	-	-
Rockland,	14	1	15	6.7	11.50	-	4	4
Salisbury,	31	10	41	24.4	10.00	-	-	-
Stoughton,	7	7	14	50.0	12.60	-	-	-
Wareham,	26	2	28	7.2	11.30	-	-	-
Watertown,	39	40	79	50.6	10.67	-	-	-
Westborough,	13	-	13	0.0	12.60	-	-	-
Weymouth,	10	9	19	47.3	11.00	-	-	-
Whitman,	26	8	34	23.5	9.25	-	-	-
Winthrop,	21	16	37	70.2	11.48	-	-	-
Summary,	869	314	1,183	26.5	9.25	12	4	6

* Skimmed milk, sold as such, of standard quality.

Milk from Suspected Producers.

Locality.	Number above Standard.	Number below Standard.	Total Samples collected.	Per Cent. below Standard.	Total Solids in Lowest Sample.
Ashland,	5	6	11	83.3	11.16
Boylston,	–	3	3	100.0	8.54
Brookfield,	2	20	22	90.9	10.24
Canton,	2	18	20	90.0	10.76
Carlisle,	13	7	20	35.0	10.95
Charlton,	–	5	5	100.0	10.63
Concord,	–	19	19	100.0	11.31
Dover,	13	7	20	35.0	11.03
Framingham,	21	11	32	34.4	8.76
Hampden,	2	2	4	50.0	11.36
Hardwick,	–	5	5	100.0	10.50
Holden,	–	4	4	100.0	9.18
Holliston,	13	8	21	38.1	10.46
Medway,	37	30	67	44.7	10.53
Millis,	23	7	30	23.3	10.37
Paxton,	8	4	12	33.3	11.73
Shrewsbury,	12	8	20	40.0	11.32
Sudbury,	10	25	35	71.5	10.00
Swansea,	15	3	18	16.7	10.32
Warren,	7	3	10	30.0	11.52
Wayland,	15	–	15	0.0	12.40
Weston,	5	–	5	0.0	12.23
Woburn,	–	5	5	100.0	10.49
Summary,	203	200	403	49.8	8.54

Summary of Milk Statistics.

	Number above Standard.	Number below Standard.	Total Samples collected.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with — Annatto.	Aniline Orange.	Caramel.	Number of Samples preserved with Formaldehyde.
Cities,	1,948	1,049	2,997	35.0	8.38	11	13	5	1	13
Towns,	869	314	1,183	26.5	9.25	12	–	4	–	6
Suspected producers,	203	200	403	49.8	8.54	–	–	–	–	–
Miscellaneous,	44	64	108	59.2	8.58	–	–	–	–	1
Summary,	3,064	1,627	4,691	34.7	8.38	23	13	9	1	20

The following table is inserted, showing the quality of the milk by months: —

Quality of Milk by Months.

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
Number having more than 15 per cent. of total solids,	26	6	18	7	10	13	15	14	18	14	11	25	177
Number having between 14 and 15 per cent. of total solids,	42	25	41	12	17	47	14	22	29	16	20	43	328
Number having between 13 and 14 per cent. of total solids,	158	63	141	57	52	138	88	108	117	60	66	150	1,198
Number having between 12 and 13 per cent. of total solids,	254	124	94	83	77	267	202	193	207	185	194	368	2,248
Number having between 11 and 12 per cent. of total solids,	26	17	13	11	9	49	71	84	57	58	66	70	531
Number having between 10 and 11 per cent. of total solids,	11	7	10	2	2	15	18	27	11	7	22	23	155
Number having between 9 and 10 per cent. of total solids,	4	1	-	1	-	2	5	5	7	2	4	6	37
Number having between 8 and 9 per cent. of total solids,	-	-	-	-	1	2	4	2	-	1	3	2	15
Number having less than 8 per cent. of total solids,	-	-	-	-	-	-	1	-	-	-	1	-	2
Totals,	521	243	317	173	168	533	418	455	446	343	387	687	4,691

Twenty-three samples of milk containing artificial coloring matter were collected from Gloucester, Lowell and Rockland. Of these, 13 samples contained annatto, 9 aniline orange and 1 caramel. But 20 samples of milk were found containing added preservative, — the smallest number for some years. Formaldehyde was in all cases the preservative used.

The following table shows statistics regarding the use of preservatives in milk for the last few years: —

Preservatives in Milk.

Year.	Samples Examined.	Number containing Formaldehyde.	Per Cent. containing Formaldehyde.	Number containing Boric Acid.	Per Cent. containing Boric Acid.	Number containing Carbonate.	Total containing Preservative.
1898,	1,046	26	2.5	11	1.0	4	41
1899,	2,105	55	2.6	13	0.6	3	71
1900,	2,018	61	3.0	6	0.3	-	67
1901,	2,154	42	1.9	12	0.5	-	54
1902,	1,934	29	1.5	14	0.7	-	43
1903,	1,935	28	1.5	11	0.4	1	40
1904,	1,863	20	1.1	-	-	-	20
Summary,	13,055	261	2.0	67	0.5	8	336

It is interesting to note the gradual decrease in the extent of the use of formaldehyde in milk since 1900. It is our custom to examine all samples of milk for preservatives through June, July, August and September. While added coloring matter in milk is usually rendered apparent to the experienced eye by the physical appearance of the milk itself, thus often giving a clue to the analyst, there is, of course, nothing at all to indicate whether preservative is present except a careful test.

The question often arises in court whether or not it is possible to analyze milk after it has become sour, since it occasionally happens in the summer time that milk from long distances sometimes reaches the laboratory not perfectly sweet. Again, it is sometimes held that certain sealed samples of milk can not be analyzed, because they are sour. As a matter of fact, while the process of lactic fermentation results in the formation of traces of volatile acids, unless the sample has become so badly curdled as to render a fine, homogeneous mixture of the various parts impossible, a perfectly fair determination of the solids and fat can readily be made. Experience has proved that, excepting in instances of milk so badly soured as to become actually putrid, the analysis of sour milk, if carefully made, should not differ materially from that of the same milk before souring.

Care must be taken to secure a fine emulsion of the curd and whey. This may sometimes be accomplished by repeatedly pouring a sample back and forth from one container to another. Again, it is sometimes necessary to use an egg-beater, especially of the spiral-wire pattern, which should preferably fit easily into the can or milk-container. Unless a fine, even emulsion can be secured, it is impossible to make a satisfactory analysis of the milk. With such an emulsion, results can be relied upon. In measuring portions of the thoroughly mixed sample of sour milk for analysis, a pipette having a large opening should be used.

Detection of Added Water.

In the analyst's report for 1903 a method was outlined for the detection of added water in milk by means of the Zeiss immersion refractometer, and additional experience with this method through the year has proved its reliability beyond a doubt. The writer knows of no other method for positively showing added water in milk, especially when the sample stands 11 per cent. or more in total solids. It has hitherto been impossible positively to allege added water in milk, unless the sample as analyzed was found to stand lower in total solids than the minimum limit for Holstein milk of known purity.

The following table shows the results of the analysis of milk of known purity taken from a herd of Holstein cows in Middlesex County, milked in the presence of the writer. These cows were kept under ordinary farm conditions, the daily ration in each case consisting of three quarts of meal, two quarts of mixed feed, and two quarts of gluten with green fodder.

Milk of Known Purity from Common Holstein Cows.

Age of Cow (Years).	Time since Calving (Months).	Determinations on Milk.								On Milk Serum.		
		Specific Gravity at 15° C.	Water (Per Cent.).	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Ash (Per Cent.).	Milk Sugar (Per Cent.).	Proteids (Per Cent.).	Specific Gravity at 15° C.	Immersion Refractometer reading at 20° C.	n_D. 20°.
6	1	1.0290	87.24	12.76	4.50	8.26	0.52	4.90	2.84	1.0258	42.9	1.343842
5	2	1.0297	87.32	12.68	4.10	8.58	0.45	4.90	3.23	1.0295	43.1	1.343918
3	9	1.0305	87.87	12.13	3.55	8.58	0.55	4.35	3.68	1.0287	41.5	1.343315
8	3	1.0302	87.89	12.11	3.65	8.46	0.50	4.90	3.06	1.0291	42.0	1.343500
5	3	1.0296	88.07	11.93	3.45	8.48	0.60	4.30	3.58	1.0271	41.4	1.343278
7	1½	1.0307	88.24	11.76	3.60	8.16	0.50	4.80	2.86	1.0291	42.1	1.343538
2	3	1.0295	88.32	11.68	3.30	8.38	0.49	4.65	3.24	1.0285	41.8	1.343426
6	4	1.0300	88.60	11.40	3.05	8.35	0.60	4.55	3.20	1.0287	40.9	1.343092
5	8	1.0285	88.83	11.17	3.25	7.92	0.53	4.10	3.29	1.0286	39.7	1.342636
6	9	1.0290	88.90	11.10	3.30	7.80	0.65	3.95	3.25	1.0266	39.9	1.342712
7	7	1.0286	89.44	10.56	2.70	7.86	0.63	3.75	3.48	1.0296	39.0	1.342370
2	2	1.0286	89.55	10.45	2.60	7.45	0.59	4.25	3.01	1.0267	40.0	1.342750
Highest, .	.	1.0307	89.55	12.76	4.50	8.58	0.60	4.90	3.68	1.0296	43.1	1.343918
Lowest, .	.	1.0282	87.24	10.45	2.60	7.80	0.45	3.75	2.84	1.0253	39.0	1.342370
Average,	.	1.0295	88.35	11.65	3.45	8.22	0.54	4.45	3.23	1.0281	41.6	1.343520

From this it may be seen that milk of known purity may contain as low as 10.45 per cent. of total solids, and even this is by no means the minimum limit.

We have hitherto claimed that it is safe to assume that, if milk stands below 10.75 in total solids with a solids not fat less than 7.30, the milk may safely be condemned as fraudulently watered. The chief advantage of the refractometric method lies in its ability to detect watered milk running between 11 and 12 per cent. in total solids.

As an example of this, I would cite the case of a suspected producer in Worcester County, whose milk, standing at 11.33 per cent. in total solids and 3.8 per cent. fat, was declared to contain added water, though without the refractometric reading of the milk serum (38.3° at 20° C.) this fact could not have been established. This sample being at the time the highest total solids on which a case of alleged added water had ever been brought, it was with some misgivings that the case was prosecuted; but the defendant, after being found guilty on the evidence, in order to relieve himself of the odium of selling watered milk, finally admitted that an employee of his, a Pole, who had been discharged by him about the time of the seizure of the milk, had been caught in the act of pouring off the tops of the cans on account of spite, and filling them up with water. This episode furnished a most satisfactory and convincing proof of the reliability of the method.

Before the minimum reading of the refractometer can be definitely fixed, it will be desirable to examine a large number of low-standard milk samples of known purity, and this, it is hoped, can be accomplished in the near future.

Condensed Milk.

Ninety-two samples of condensed milk were analyzed, 12 of which were found to consist of condensed skimmed milk. Following are the results of the analysis of the newer brands, or those not recorded in recent years; these were analyzed in full: —

Condensed Milk.

Brand.	Total Solids (Per Cent.).	Water (Per Cent.).	Milk Solids (Per Cent.).	Cane Sugar (Per Cent.).	Milk Sugar (Per Cent.).	Proteids (Per Cent.).	Fat (Per Cent).	Ash (Per Cent.).	Fat in Original Milk (Per Cent.).
Regal, . . .	73.69	26.31	30.28	43.41	10.92	7.92	9.90	1.43	4.52
Triangle, . .	72.38	27.62	29.86	42.52	9.82	8.59	10.05	1.40	4.40
Brindle Cow, . .	70.77	29.23	30.80	39.97	9.84	10.08	9.30	1.58	4.03
Wingold, . .	73.48	26.52	27.60	45.88	6.87	9.75	9.30	1.60	3.94
Red Clover, . .	71.58	28.42	27.46	44.12	10.46	7.35	7.95	1.70	3.80
White Pansy, . .	72.94	27.06	32.90	40.04	11.06	11.20	9.15	1.49	3.61
Rob Roy, . .	74.14	25.86	29.63	44.51	13.02	7.85	7.20	1.56	3.31
Stamp, . . .	71.92	28.08	29.16	42.76	11.32	9.58	6.75	1.51	3.20
Jaxon, . . .	74.33	25.67	33.13	41.20	12.94	10.31	8.40	1.48	3.16
O'Keeffe's Shamrock.	75.80	24.20	31.66	44.14	12.38	9.91	7.80	1.57	3.05
Anchor, . . .	75.71	24.29	31.69	44.02	12.82	9.51	7.80	1.56	3.03
Farm Favorite, .	72.87	27.13	32.51	40.36	13.24	9.44	7.95	1.88	3.02
Middlesex, . .	75.32	24.68	33.37	41.95	13.24	10.74	7.80	1.59	2.83
Sailor Boy, . .	69.66	30.34	36.17	33.49	11.46	17.50	5.40	1.81	2.10

Evaporated "Cream."

Top Notch, . .	27.25	72.75	27.25	-	10.30	8.26	7.50	1.10	4.63
Columbia, . .	29.27	70.73	29.27	-	11.18	9.57	7.75	1.25	4.36
Ideal, . . .	34.29	65.71	34.29	-	12.36	7.75	10.20	1.45	4.43
Pet,. . . .	-	-	-	-	-	-	7.35	2.45	4.16
Borden's Peerless,.	-	-	-	-	-	-	7.80	1.43	3.64
Top Notch, . .	-	-	-	-	-	-	6.73	1.33	3.55
St. Charles, . .	-	-	-	-	-	-	6.60	1.64	2.85
Top Notch, . .	29.51	70.49	29.51	-	11.24	9.23	6.90	1.23	2.84

The following are old brands, or those previously examined, determinations of the fat and ash only being made in each case in order simply to ascertain the general quality of the milk: —

Condensed Milk.

Brand.	Ash (Per Cent.).	Fat (Per Cent.).	Fat in Original Milk (Per Cent.).	Brand.	Ash (Per Cent.).	Fat (Per Cent.).	Fat in Original Milk (Per Cent.).
Lennox, . .	1.65	10.35	4.39	Willow Farm, .	1.62	7.80	3.41
Owl, . . .	1.64	10.20	4.33	Jaxon, . .	1.80	8.70	3.38
Something New, .	1.51	9.30	4.32	Eagle, . . .	1.67	7.95	3.32
Challenge, . .	1.30	7.80	4.20	Winner, . .	1.59	8.40	3.27
Perfection, . .	1.55	9.00	4.07	Eagle, . . .	1.55	7.20	3.25
Defiance, . .	1.49	8.55	3.99	Gray's, . .	1.83	8.25	3.17
Tip Top, . .	1.67	9.45	3.95	Purity, . .	1.69	7.20	2.96
Vermont, . .	1.38	7.80	3.90	Chief, . . .	1.58	6.37	2.82
Rose, . . .	1.68	9.45	3.88	Regal, . . .	1.60	6.30	2.74
Nestler, . .	1.69	8.85	3.64	Rooster, . .	2.07	7.95	2.71
Merit, . . .	1.68	8.55	3.62	Silver, . . .	1.94	7.50	2.70
Ginter's, . .	1.59	8.25	3.61	O'Keeffe's, . .	1.57	6.15	2.69
Blue Bell, . .	1.65	8.22	3.49	O'Keeffe's, . .	1.60	6.00	2.62
Standard, . .	1.52	7.50	3.45	Plume, . .	1.54	5.40	2.46
Connor's, . .	1.86	9.00	3.41				

While it is impossible to determine exactly the quality of the original milk from the analysis of a condensed sample of sugar-preserved milk, quite satisfactory approximate results have been obtained by the methods published in our former reports. A more satisfactory method of calculating the fat in the original milk consists in reducing the fat and the milk solids to the basis of the cane-sugar-free sample. This is done by dividing the per cent. of each as found in the sample by 100, less the percentage of cane sugar, and multiplying the result by 100; then ascertaining the difference between the milk solids and the fat thus obtained in the cane-sugar-free sample, and dividing this percentage of milk solids not fat by 9.3, which is assumed as the percentage of solids not fat in the original milk. The result is "the number of times condensed" (if cane sugar were not present as a diluent). The per cent. of fat in the cane-sugar-free sample, divided by "the number of times condensed," as above obtained, gives approximately the percentage of fat in the original milk.

By assuming the highest reasonable figure for solids not fat, it is readily seen that the highest result is obtained for the fat in the original milk; and hence the benefit of any doubt as to the use of skimmed milk is given to the manufacturer.

Cream.

Seven samples of cream were examined for preservatives, 1 of which was found to contain formaldehyde.

Butter.

Two hundred and seventeen samples of butter were examined, of which 8 were declared adulterated, being "renovated butter" sold without proper regard to labelling. It should be said that many more samples of "renovated butter" were received, but, with the exception of 8, all were sold and marked in accordance with the law.

Cheese.

Sixty samples of cheese were examined, of which 13 were pronounced adulterated, 2 of these by reason of the fact that they were skimmed-milk cheese, and 1 as containing boric acid without being labelled. A skimmed-milk cheese is at once indicated if the fat is considerably less than the proteids.

The following brands of cheese were found to be adulterated: —

Published Results of Analyses of Cheese.

Variety.	Brand.	Results of Analyses.
Neufchatel,	Worcester County M. R. B.,	Skimmed-milk cheese.
Neufchatel,	Crescent,	Skimmed-milk cheese.
Soft cheese,	MacLaren's Imperial,	Preserved with boric acid; no formula.

MacLaren's Imperial cheese, it should be said, was afterwards sold in packages bearing a formula specifying the presence of boric acid, in accordance with the law.

Cocoa.

Twenty-one samples of cocoa were examined, of which 17 were found to be adulterated. The adulterants found were, as usual, sugar, corn and wheat starches, and cocoa shells. The presence, under the microscope, of an abnormally large number of yellow and brown fragments in the water-mounted cocoa specimen, even under small magnification, rouses suspicion of the presence of shells, the most distinct elements of which are the spongy tissue, the stone shells and the abundant spiral ducts, the latter being scarce in pure cocoa powder. Cocoa shells are indicated on chemical analysis by the abnormally high ash and crude fiber.

The following brands of cocoa were published in the monthly bulletins as being adulterated: —

Published Results of Analyses of Cocoa.

Brand.	Manufacturer or Wholesaler.	Result of Analysis.
Homestead Breakfast, "Guaranteed absolutely pure."	E. V. Miller, Cash Grocer, Rockland, Mass.	Admixture of cornstarch.
Superior Lunch Cocoa, manufactured in America, "Warranted pure,"	- -	Large admixture of sugar.
Sterry's,	Sterry & Sterry, New York,	Cocoa shells.
Acme Lunch Cocoa,	Brewster Cocoa Manufacturing Company, Jersey City, N. J.	Large admixture of sugar and wheat.

Coffee.

Of the 90 samples examined, 4 were found to be adulterated, the adulterants found being peas, pea hulls, chicory and sugar. Two brands reported as adulterated were "Coffey's Soluble Coffee, Premium Brand," put out by the Fulton Mills, New York, containing 30 per cent. sucrose, without a proper label; and "Café des Invalides, or Antidote Coffee," manufactured by the S. S. Pierce Co. of Boston, a compound not labelled according to law.

A careful examination of the crushed grains of the ground coffee sample with the naked eye will often serve to detect, and in some cases identify, certain adulterants, especially cereal grains, peas and chicory. A still more effective method of examining the grains themselves consists in the use of a dissecting microscope with a low-power magnifier, observing the grains as they lie scattered over a white enamel plate. The writer uses for this purpose a dissecting microscope with an inch and a half objective, mounted in a Bausch and Lomb compound erecting eyepiece.

The chicory grains are apparent from their dark and somewhat gummy appearance, and can usually be recognized by crushing them between the teeth. Their soft consistency and bitter taste are very distinctive. The dull surface of the outside of the crushed coffee grains is in marked contrast to the polished appearance of the surface of the broken peas or beans often to be found as adulterants, while fragments of broken cereal grains are readily distinguished from coffee with a low-power magnifier, though perhaps not easily identified by the eye alone.

Fifteen samples of coffee of known purity (3 each of the following brands: Santos, Porto Rico, Rio, Mocha and Java coffee) were analyzed in full in this laboratory by H. C. Lythgoe, who, as referee on tea and coffee of the Association of Official Agricultural Chemists, has been working up methods of analysis of these products for provisional adoption by the association.

The following are the results of these analyses, together with those of several samples of coffee substitutes and of adulterated coffee taken from samples collected: —

TABLE 1.—*Analyses of Roasted Coffee.*

Variety.		Moisture (Per Cent.).	Ash (Per Cent.).	Water-soluble Ash (Per Cent.).	Sand (Per Cent.).	Chlorine (Per Cent.).	Alkalinity of Ash of 1 Gram of Substance (c.c. n/10 Acid).	Alkalinity of 1 Gram of Ash (c.c. n/10 Acid).	Soluble P_2O_5 (Per Cent.).	Insoluble P_2O_5 (Per Cent.).	Petroleum Ether Extract. (Per Cent.).	Petroleum Ether Extract. $n_D30°$.	Total Nitrogen (Per Cent.).
Santos,	A,	1.40	4.16	3.46	.00	.023	2.97	71.4	.319	.346	14.58	1.4754	2.26
	B,	1.87	4.31	3.62	.00	.023	3.36	75.7	.286	.295	13.64	1.4754	2.26
	C,	1.31	3.80	3.00	.00	.019	3.35	85.6	.278	.295	13.36	1.4750	2.39
Porto Rico,	A,	1.29	4.05	3.30	.00	.016	3.53	87.2	.305	.337	13.00	1.4752	2.28
	B,	1.26	4.06	3.27	.00	.020	3.72	92.6	.226	.351	13.34	1.4750	2.26
	C,	1.48	4.12	3.32	.00	.016	3.66	88.8	.333	.328	14.12	1.4760	2.33
Rio,	A,	1.76	4.06	3.40	.00	.020	4.16	102.3	.218	.166	13.38	1.4758	2.14
	B,	2.34	3.91	3.24	.00	.021	3.17	81.2	.356	.227	13.71	1.4753	2.18
	C,	2.10	3.74	3.06	.00	.023	3.22	86.6	.363	.236	13.53	1.4756	2.26
Mocha,	A,	2.05	4.05	3.25	.00	.016	3.94	97.4	.282	.351	14.84	1.4737*	2.28
	B,	2.95	3.85	3.07	.00	.021	3.26	84.7	.333	.364	14.47	1.4743*	2.00
	C,	2.40	3.80	3.00	.00	.012	3.54	93.3	.337	.545	15.18	1.4740*	2.02
Java,	A,	3.34	4.09	3.27	.00	.016	3.88	95.0	.258	.421	12.61	1.4752	2.48
	B,	3.35	4.38	3.56	.00	.019	3.54	80.8	.194	.388	12.28	1.4758	2.35
	C,	3.44	3.96	3.10	.00	.011	2.95	74.5	.235	.383	13.54	1.4752	2.56
Highest,		3.44	4.38	3.62	.00	.023	4.16	102.3	.424	.545	15.18	1.4760	2.56
Lowest,		1.29	3.74	3.00	.00	.011	2.95	71.4	.194	.166	12.28	1.4750	2.00
Average,		2.16	4.03	3.26	.00	.018	3.55	87.1	.285	.329	13.75	1.4754	2.27

* Omitted from average.

TABLE 1.—*Analyses of Roasted Coffee*—Concluded.

Variety.		Cold-water Extract (Per Cent.).	Alcohol Extract (Per Cent.).	Reducing Sugars (Per Cent.).	"Starch"* by Diastase (Per Cent.).	Crude Fiber (Per Cent.).	Caffeine (Per Cent.).	Ten Per Cent. Extract. Specific Gravity at 15°.	Immersion Refractometer Reading at 20°.	Index of Refraction at 20° (n_D).	Solids (Per Cent.).	Ash (Per Cent.).
Santos,	A,	20.80	16.83	0.52	2.28	13.41	1.25	1.0107	26.7	1.33770	2.64	.40
	B,	22.72	17.11	0.58	1.00	11.02	1.10	1.0108	26.9	1.33777	2.66	.39
	C,	21.70	17.80	0.75	2.32	14.71	1.20	1.0101	26.0	1.33748	2.46	.30
Porto Rico,	A,	22.48	15.70	0.50	2.17	13.11	1.38	1.0107	26.6	1.33766	2.60	.37
	B,	21.76	16.36	0.63	1.56	12.98	1.21	1.0104	26.3	1.33754	2.50	.36
	C,	24.44	16.91	0.54	2.62	12.50	1.32	1.0113	27.6	1.33804	2.77	.30
Rio,	A,	22.66	17.00	0.68	2.82	14.08	1.11	1.0103	25.5	1.33724	2.48	.40
	B,	22.61	17.34	0.78	1.47	13.10	1.10	1.0101	25.8	1.33735	2.46	86
	C,	22.75	17.37	0.61	2.62	11.91	1.17	1.0101	26.0	1.33743	2.46	.30
Mocha,	A,	24.00	18.01	1.78	2.30	11.22	1.16	1.0106	26.4	1.33758	2.65	.40
	B,	20.27	17.96	0.94	1.85	12.34	1.10	1.0101	26.3	1.33754	2.47	.36
	C,	24.18	19.55	1.42	2.90	13.20	1.18	1.0111	27.3	1.33793	2.72	.40
Java,	A,	23.85	15.95	0.32	2.95	13.43	1.34	1.0110	26.9	1.33777	2.63	.39
	B,	22.19	15.45	0.42	2.32	13.77	1.30	1.0107	26.5	1.33762	2.58	.38
	C,	23.20	16.21	0.66	3.34	14.75	1.27	1.0108	26.6	1.33766	2.62	.38
Highest,		24.44	19.55	1.78	3.34	14.75	1.34	1.0113	27.6	1.33804	3.77	.40
Lowest,		20.27	16.45	0.32	1.00	11.02	1.00	1.0101	26.0	1.33743	2.46	.30
Average,		22.63	17.03	0.75	2.30	13.03	1.20	1.0105	26.6	1.33766	2.72	.37

* Reducing substance not starch but reckoned as such.

TABLE II. — *Analyses of Coffee Substitutes and of Adulterated Coffee.*

VARIETY.	Moisture (Per Cent.).	Ash (Per Cent.).	Water-soluble Ash (Per Cent.).	Sand (Per Cent.).	Chlorine (Per Cent.).	Alkalinity of Ash of 1 Gram of Substance (c.c. n/10 Acid).	Alkalinity of 1 Gram of Ash (c.c. n/10 Acid).	Soluble P_2O_5 (Per Cent.).	Insoluble P_2O_5 (Per Cent.).	PETROLEUM ETHER EXTRACT. Per Cent.).	PETROLEUM ETHER EXTRACT. $n_D30°$.	Total Nitrogen (Per Cent.).
Roasted wheat, .	5.60	5.71	2.82	.00	-	0.34	6.0	.649	1.460	2.40	-	1.84
Roasted chicory, .	5.55	4.37	2.27	.51	.080	0.95	21.8	.277	0.314	0.88	-	1.10
Coffee and chicory, .	5.08	3.96	3.14	.06	.026	3.05	77.0	.286	0.323	8.32	-	1.89
Coffee, chicory and pea hulls.	3.64	4.97	4.05	.24	*.284	2.60	65.6	.472	0.740	9.56	-	2.17

* Admixture of salt.

TABLE II. — *Analyses of Coffee Substitutes and of Adulterated Coffee* — Concluded.

VARIETY.	Cold-water Extract (Per Cent.).	Alcohol Extract (Per Cent.).	Reducing Sugars (Per Cent.).	Starch by Diastase (Per Cent.).	Crude Fiber (Per Cent.).	Caffeine (Per Cent.).	TEN PER CENT. EXTRACT. Specific Gravity at 15°.	Immersion Refractometer Reading at 20°.	Index of Refraction at 20° (n_D).	Solids (Per Cent.).	Ash (Per Cent.).
Roasted wheat, .	25.88	10.72	4.10	28.58	6.23	0.00	-	-	-	-	-
Roasted chicory,	72.92	34.39	19.34	2.10	5.91	0.00	1.0307	45.0	1.34463	7.44	.26
Coffee and chicory.	31.79	21.66	5.06	2.21	14.31	0.95	1.0142	30.5	1.33915	3.62	.29
Coffee, chicory and pea hulls.	25.00	14.25	3.00	3.78	17.87	1.00	-	-	1.47450	-	-

For these methods in full, see "Proceedings of the Twenty-first Annual Convention of the Association of Official Agricultural Chemists."

CONFECTIONERY.

Of 34 samples analyzed, one only was pronounced adulterated, by reason of the presence of an undue amount of paraffine.

CREAM OF TARTAR.

Two hundred and seventy samples were analyzed, 6 of which were adulterated. The adulterants found were calcium acid phosphate, gypsum and starch. Most of the adulterated brands were bulk goods, but one, the Star Brand of Pulverized Cream of Tartar, "extra fine, guaranteed as to quality and strength," was found to contain a large admixture of the above adulterants.

Flavoring Extracts.

Almond Extract.

Twenty-four samples were examined, 4 of which were found to contain hydrocyanic acid. According to the Pharmacopœia, essence of bitter almonds should contain 1 per cent. by volume of almond oil in strong alcohol. The official essence of the Pharmacopœia does not specify that the almond oil used should be perfectly free from hydrocyanic acid, in spite of the fact that its highly poisonous nature is well known, and that it exists in the crude oil to the extent of from 4 to 6 per cent. True, but little of it is found in the extract; but in these days, when the unannounced presence in food of such substances as antiseptics and coloring matters is regarded as questionable from a sanitary stand-point, in spite of the fact that their physical effects on man are still matters of controversy, there should be little hesitancy in pronouncing the presence of prussic acid objectionable, especially when a pure almond oil entirely free from it is readily obtainable.

The presence of nitrobenzol or oil of mirbane as a substitute for almond oil was looked for, but was not found in any of the extracts sold in this market. The following methods were employed: —

Distinction between Benzaldehyde and Nitrobenzol. — Treat 20 cubic centimeters of the extract with 5 to 10 cubic centimeters of a cold, saturated solution of sodium bisulphite in a test tube, and shake vigorously. Transfer to an evaporating dish, and heat on the water bath until the alcohol is driven off. At this stage benzaldehyde remains in the heated solution as a crystalline solid, and the solution gives off no almond odor. Nitrobenzol, on the contrary, does not combine with the bisulphite, and is insoluble, forming globules of oil on the surface of the heated liquid, and, in addition, giving off the pungent odor so characteristic of the substance.

Determination of Benzaldehyde. — In case nitrobenzol by the qualitative test is found to be absent, shake vigorously 50 cubic centimeters of the extract with 20 cubic centimeters of the saturated sodium bisulphite solution in a stoppered flask, transfer to an evaporating dish, and heat on the water bath till the alcohol has disappeared, keeping up the original volume by the occasional addition of water. Note the odor of the solution at frequent intervals during evaporation, and if at any time the least odor of escaping benzaldehyde is apparent, stir in at once a few drops more of the bisulphite solution. Cool, dilute with water slightly, make strongly alkaline with sodium hydroxide, and extract in a separatory funnel with four portions of low-boiling petroleum ether, of 15 to 20 cubic centimeters each. Wash the combined petroleum ether twice with water, and, after removal of the water, transfer it to a tared dish, and allow it to evaporate spontaneously at room temperature. Finally, weigh the residue.

By reason of the volatility of benzaldehyde and its tendency to oxidize to benzoic acid, the results are only approximate.

Separation of Nitrobenzol and Benzaldehyde. — If by the qualitative test nitrobenzol is found, shake vigorously as before 50 cubic centimeters of the extract with 10 cubic centimeters of the saturated sodium bisulphite solution in a corked flask, and transfer with 100 cubic centimeters of water to a large separatory funnel. Shake out the nitrobenzol from the solution with four successive portions of petroleum ether, of 15 to 20 cubic centimeters each, and after washing with water the combined petroleum ether, transfer it to a tared dish, in which it is allowed to evaporate spontaneously.

It is extremely difficult to avoid loss of some of the nitrobenzol by this process, but, even if the weighed residue fails to show the full amount originally used, enough will usually be extracted to admit of testing on the refractometer, and of otherwise verifying its character.

After removal of the nitrobenzol, make the residual solution in the separatory funnel strongly alkaline with sodium hydroxide, and shake out the benzaldehyde, if present, with petroleum ether, as previously described. If after making the solution alkaline no odor of benzaldehyde is apparent, the absence of benzaldehyde may be inferred.

Distinction between Artificial Benzaldehyde and Pure Almond Oil. — Test the final residue from the ether extract by shaking with an equal volume of concentrated sulphuric acid in a test-tube. With natural oil of almonds a clear, brilliant, but dark currant-red color is produced; while with artificial benzaldehyde the acid produces a dirty brown color, with the formation of a precipitate.

Determination of Alcohol. — In the absence of other flavoring substances than nitrobenzol and benzaldehyde, which are rarely present to an extent exceeding 1 per cent., a sufficiently close approximation for most purposes can be gained by estimating the alcohol from the direct specific gravity of the extract.

Detection of Hydrocyanic Acid. — To a few cubic centimeters of extract in a test-tube add a few drops of a mixture of solutions of ferrous sulphate and ferric chloride, the ferrous salt being in excess. Make alkaline with sodium hydroxide, and add enough dilute hydrochloric acid to dissolve the precipitate formed by the alkali. Presence of a blue coloration or precipitate, due to the formation of Prussian blue, indicates hydrocyanic acid. The reaction is very delicate.

*Determination of Hydrocyanic Acid.** — Hydrocyanic acid may be determined by titration with tenth-normal silver nitrate solution. Twenty-five cubic centimeters of the extract are measured into a flask, and 5 cubic centimeters of freshly prepared magnesium hydroxide suspended in water are added, or enough to make the reaction alkaline.

* Vielhaber, Arch. Pharm. (3), 13, 408.

A few drops of a solution of potassium chromate are then introduced, and the tenth-normal silver nitrate solution added, till, with shaking, the formation of the red silver chromate indicates the end-point. One cubic centimeter of silver solution equals .0027 gram of hydrocyanic acid.

Banana Extract.

Two samples of "banana extract" were examined, both of which, being plainly marked artificial, were adjudged in accordance with the law.

It is obviously a fraud to put out these synthetic or artificial fruit essences as "pure fruit extracts."

Jamaica Ginger Extract.

The single sample of this extract brought in for analysis was pronounced adulterated, containing a trace only of ginger oil. This was the "Banner" brand, Simpson Spring Company, Boston.

Lemon Extract.

Thirty-two samples were examined, of which 19 were pronounced adulterated. Lemon extracts sold as pure, without formulæ and containing no lemon oil whatever, though very common in our market two or three years ago, are now rarely found. Nearly all the cheap extracts bear some variety of formula, but in many cases the formula is incorrect, if not entirely misleading.

The following brands of lemon extract were advertised as adulterated: —

Published Results of Analyses of Lemon Extracts.

Brand.	Manufacturer and Wholesaler.	Statement on Formula.		Result of Analysis.	
		Lemon Oil (Per Cent.).	Alcohol (Per Cent.).	Lemon Oil (Per Cent.).	Alcohol (Per Cent.).
——,	Walker Chemical and Extract Company, Chelsea, Mass.,	3.0	66.00	0.94	59.80
——,	Ragus Tea and Coffee Co., New York,	-*	-*	0.60	60.00
——,	L. W. Manning, Somerville, Mass.,	-*	-*	1.40	51.80
Kidder's Concentrated,	Kidder & Co., Boston, Mass.,	-*	-*	1.30	70.99
Royal Arms,	International Extract Company, New York,	-*	-*	0.00	-†
Acme,	Acme Extract Co., Binghampton, N. Y.,	-*	-*	0.60	37.34
——,	E. M. Chace Tea Co., Manchester, N. H.,	-*	-*	3.30	79.60
——,	Zopher Company, Lowell, Mass.,	-*	-*	0.10	48.75
——,	Elmo Extract Company, Somerville, Mass.,	3.0	-	1.40	44.19
——,	Eagle Extract Company, Boston, Mass.,	3.0	-	1.30	-
Favorite,	Highland Extract Company, Boston, Mass,	2.3	-	trace	-
Pure concentrated,	- -	-*	-*	0.00	-
——,	Oriental Drug Company, Boston, Mass.,	2.5	-	0.10	-
Derby,	Derby Food Producing Co., Boston, Mass.,	3.0	70.00	1.00	50.11

* No formula. † Cane sugar present.

Orange Extract.

The single sample of this extract examined was found to be of good quality.

Peppermint Extract.

Two samples of peppermint extract were examined, one of which, put out by Harrison & Co. of Providence, R. I., contained only a trace of oil of peppermint, with 16 per cent. alcohol by volume.

Vanilla Extract.

Thirty samples were analyzed, of which 3 were pronounced adulterated.

HONEY.

Forty-two samples were examined, 4 of which were adulterated. The usual adulterants found were glucose and cane sugar.

The following brands were published as adulterated: —

Published Results of Analyses of Honey.

BRAND.	Manufacturer or Wholesaler.	Results of Analysis.
Wild Rose California, . . .	San Diego Honey Company, San Francisco, Cal.	Admixture of glucose and cane sugar.
Jamaica Mountain, . . .	Smith & Cheeney, Boston, Mass., .	Admixture of glucose and cane sugar.

LARD.

Twenty-five samples were examined, 9 of which were found to be adulterated with cotton-seed stearine. The presence of cotton-seed oil is best indicated by Halpen's test.

MAPLE SUGAR AND SYRUP.

Eighteen samples of maple sugar were examined, 6 of which were found adulterated with refined cane sugar. Forty-six samples of the syrup were analyzed, 28 of which were similarly adulterated.

The presence of refined cane sugar in maple products is readily detected in a positive manner, though the popular belief still holds that pure white sugar cannot be detected. As a matter of fact, it is the impurities of the maple sugar in the strict sense of the term that give to it its commercial value, and in so far as these impurities are diluted or displaced by the pure or refined sugar, to just such an extent is the adulteration rendered apparent.

The Hortvet centrifugal method of measuring the precipitate, caused by treatment of the sample in solution with lead acetate, taken in connection with the amount and character of the ash, are almost invariably sufficient to determine the purity of the product, excepting in the case of molasses or brown sugar, in which case a determination of the reducing sugars in addition is necessary.

The following brands of maple syrup were found to be adulterated: —

Published Results of Analyses of Maple Syrup.

Brand.	Name and Address of Manufacturer, Wholesaler or Producer.	Results of Analyses.								
				Calculated to Dry Substance.						
		Polarization.	Moisture (Per Cent.).	Ash (Per Cent.).	Water Soluble Ash (Per Cent.).	Alkalinity of Ash of 1 Gram of Syrup (c. c. n/10 Acid).	Alkalinity of 1 Gram of Ash (c. c. n/10 Acid).	Reducing Sugars (Per Cent.).	Hortvet Test (c. c.).	Per Cent. of Refined Cane Sugar Syrup.
——,	E. E. Gray, Company, Boston, Mass.,	61.2	34.31	.13	.08	.21	169	4.80	0.75	85
——,	J. H. Folkins & Co., Boston, Mass.,	61.2	32.56	.14	.09	.13	89	3.50	1.26	85
Metropolitan,	J. H. Folkins & Co., Boston, Mass.,	59.4	31.84	.15	.09	.19	125	7.13	0.78	80
Metropolitan,	J. H. Folkins & Co., Boston, Mass.,	21.1	36.79	.27	.17	.27	99	36.37	0.44	-*
Manhattan,	J. H. Folkins & Co., Boston, Mass.,	60.0	30.01	.17	.10	.17	100	7.92	0.61	80
Spindle City,	Mansfield, Whitam & Co., Lowell, Mass.,	64.6	30.39	.17	.14	.11	65	3.09	0.36	80
——,	W. A. Little & Co., Andrew Square, Boston, Mass.,	59.6	35.30	.03	.01	.04	122	6.15	0.23	90
——,	W. A. Little & Co., Andrew Square, Boston, Mass.,	64.0	31.34	-	-	-	-	-	0.64	70
Brunswick,	Eldridge, Baker & Bain, Boston and Salem, Mass.,	61.0	30.85	.19	.12	.14	82	5.32	0.87	75
Victor,	Saville, Somes & Co., Boston, Mass.,	61.2	34.82	.08	.03	.07	114	6.59	0.00	90
——,	E. D. Pettengill Company, Portland, Me.,	60.4	27.33	.26	.23	.33	128	4.04	0.41	65
——,	E. T. Cowdrey & Co., Boston, Mass.,	59.8	33.39	.41	.32	.36	87	4.23	0.84	50†
Champion,	C. A. Reed, Medford, Mass.,	64.0	26.45	.15	.07	.13	87	3.42	0.24	80
Whitcher's. "Warranted pure,"	Ayer Preserving Company, Ayer, Mass.,	65.0	25.27	.08	.06	.09	114	1.35	0.00	95
Victor,	Simpson Spring Company, South Easton, Mass.,	65.7	22.62	.15	.10	.19	119	2.56	0.04	80
Boston,	J. P. & D. Plummer, Boston, Mass.,	61.3	28.52	.11	.07	.15	131	3.57	0.25	85
Green Mountain,	W. J. Lamb, West Somerville, Mass.,	61.1	33.52	.18	.11	.23	127	4.50	0.84	75
Golden Tree,	New England Maple Syrup Company, Boston, Mass,	60.4	29.08	.16	.10	.13	87	5.41	0.45	80
Green Mountain,	Haskell, Adams & Co., Boston, Mass.,	62.3	34.53	.06	.02	.07	120	2.84	0.12	90
Rival,	Haskell, Adams & Co., Boston, Mass.,	60.0	32.88	.21	.12	.01	72	2.49	1.19	70
Fancy Vermont. "Guaranteed pure,"	Haskell, Adams & Co., Boston, Mass.,	62.2	29.36	.07	.03	.03	40	1.59	0.43	90
——,	Cobb, Bates & Yerxa, Boston, Mass.,	61.7	27.23	.47	.22	.91	194	3.29	1.73	45
Gold Leaf,	Huntington Maple Syrup and Sugar Co., Providence, R. I.,	61.0	28.54	.15	.05	.38	245	5.87	1.12	80
Moody's Matchless,	Charles E. Moody & Co., Boston, Mass.,	50.6	32.25	.16	.06	.50	324	10.87	1.10	80

* Seventy per cent. brown sugar syrup.

† "This syrup is guaranteed to be made from pure maple and cane sugar, and contains no glucose."

Molasses.

Sixty-nine samples were examined, 5 of which were adulterated by reason of the presence of commercial glucose. The worst sample contained 54.8 per cent. of glucose.

Spices.

Gross adulteration of this class of condiments with absolutely foreign material is now much less prevalent in the Massachusetts market than formerly. Where a few years ago it was not uncommon to find samples with from 20 to 80 per cent. of such adulterants as cocoanut shells, ground fruit stones and cereal starches, to-day the tendency is to cheapen these products by the use of low-grade or inferior spice materials, or by refuse products from the stems or adjoining plant tissues which furnish the spices themselves. Thus, for example, in cloves we find now more than formerly a larger proportion of clove stems; while the pepper shells left in the process of decorticating the berries for white pepper are themselves ground and sold as black pepper, or used as a common adulterant thereof.

Exhausted spices left as a residue from the manufacture of the expensive volatile spice oils are often used as the basis of many of the cheaper grades of these spices. This is especially true in the case of cassia, ginger and cloves.

It is very rare that the microscope will fail to detect the presence of any foreign substance in spice, and hence its use is indispensable in the examination of this class of foods. On account of the changed character of the adulteration of spices, as above indicated, chemical methods are becoming more and more necessary, showing in some cases adulteration not readily apparent by the microscope, especially in the case of exhausted spices, or those deprived of the whole or a part of their volatile oil. Sophistication of this kind is indicated best by the ether extract.

Allspice. — One hundred and fifty-nine samples were examined, 5 of which were adulterated. The common adulterants found were exhausted cloves and ginger.

Cassia. — Only 1 sample out of 192 examined during the year was found to be adulterated, this containing a large admixture of roasted wheat, foreign wood fiber and dirt.

Cayenne. — All 50 of the samples submitted for examination were found to be pure.

Cloves. — Of 166 samples analyzed, 16 were found to be adulterated. The most common form of adulteration was found to consist in the use of an excess of clove stems. Exhausted cloves and ginger were also found as adulterants.

Clove stems are best identified under the microscope by the large number of bast fibers and stone cells, and should not be found in pure cloves in

excess of 5 per cent. They are also rendered apparent by the abnormally high crude fiber, which in straight clove stems amounts to from 13 to 19 per cent. The use of exhausted cloves is indicated by the determination of the volatile ether extract, which in pure cloves is rarely lower than 11 per cent. In one instance, where the presence of exhausted cloves was alleged, the volatile ether extract was as low as 6.72 per cent., and in another instance 7.27 per cent. Note the first two samples in the table of adulterated spices.

Ginger. — Two hundred and sixteen samples were examined, 4 of which were found to be adulterated. The worst sample consisted largely of wheat and buckwheat. Other adulterants found were turmeric and exhausted ginger.

Two kinds of exhausted ginger are commercially available for admixture with ground spice as an adulterant. One is the product left after extraction with strong alcohol in the making of extract of ginger, and the other the residue from the extraction, with either very dilute alcohol or water, in the manufacture of ginger ale. Ground exhausted ginger is rarely substituted wholly for the pure spice, since its lack of pungency would at once indicate its presence. It is rather used in varying proportions in admixture with the pure spice. Indeed, it is found as a common adulterant not only of ginger, but also of other spices.

The alcohol-extracted variety of exhausted ginger is of course rendered apparent, when present in considerable amount, by the low alcohol and ether extract; while the water-extracted variety is indicated by an abnormally low cold-water extract and water-soluble ash.

One sample, the analysis of which indicated the presence of the water-extracted variety, showed a cold-water extract of 11.45 per cent. and a soluble ash of 1.11 per cent.

Mustard. — Two hundred and twenty-six samples were examined, 31 of which were pronounced adulterated. The most common adulterants were mustard hulls in excess, together with frequent examples of the starch-containing weed seed so indicative of Dakota mustard. The wheat and turmeric mixtures, which ten years ago were so commonly sold as mustard, containing, as a rule, less than 10 per cent. of pure mustard, are now rarely found in this State, and only 3 samples of this variety were found this year, two of which were bulk goods, and the other Sadtler's "Celebrated Old English Mustard." (See following table of adulterated spices.)

Mace. — Thirty-one samples were examined, 12 of which were found to be adulterated in nearly every instance with wild or Bombay mace, and in some cases with corn starch. One sample of bulk goods was found to consist almost entirely of corn starch and wild mace. The microscope at once indicates when Bombay mace is present in a sample. The oil glands in the outer layers of Bombay mace are very strongly colored, and contain a deep-red resinous substance, very different from anything to be found in true mace. The glands of the more interior layers of wild mace have, moreover,

a balsam-like substance, of a bright yellow color. The presence of Bombay mace is indicated under the microscope by the presence of both the red and the yellow lumps in a water-mounted sample of the spice.

Nutmeg. — One sample of the 16 examined was found to be adulterated. This was found to consist almost entirely of wild mace, containing no nutmeg whatever.

Pepper. — Three hundred and forty-six samples were examined, 13 of which were found to be adulterated. The worst sample consisted largely of wheat starch. (See that of the Ragus Tea and Coffee Company, in the following table of adulterated spices.)

The most common adulterant was found to be pepper shells in excess of the proportion found in the whole ground berry. The presence of an abnormally large amount of pepper shells is indicated by the high ash, the limit of ash fixed by the United States standard for pepper being 7 per cent. The microscope will usually indicate an undue proportion of pepper shells by reason of the excess of the stone cells of the outer coating of the berry.

The following list of adulterated brands of spices is only a small part of those found to be adulterated during the year, because it is for the most part in bulk goods, bearing no clue to the manufacturer, that the worst forms of adulteration are to be expected.

Published Results of Analyses of Spices.

Spice.	Brand.	Manufacturer or Wholesaler.	Results of Analyses.
Cloves, .	Eastern, ...	American Japan Tea Company, Springfield, Mass.	Largely clove stems and exhausted cloves.
Cloves, .	O K, ...	M. O'Keeffe, Boston, Mass., .	Admixture of exhausted cloves.
Ginger, .	- -	Ragus Tea and Coffee Company, New York.	Admixture of wheat and buckwheat.
Ginger, .	Eastern, ...	American Japan Tea Company, Springfield, Mass.	Admixture of exhausted ginger.
Ginger, .	Royal. "Guaranteed absolutely pure."	Dwinell Wright Company, Boston, Mass.	Large admixture of turmeric.
Mustard,	Eureka. "Absolutely pure."	H. Belanger, Haverhill, Mass.,	Excess of starch-containing weed seed.
Mustard,	Extra Strong, Double Superfine.	- -	Mustard hulls.
Mustard,	- -	B. Fischer & Co., New York,	Colored with turmeric.
Mustard,	Ardenter, ...	W. S. Dean & Son, New York,	Admixture of starch and turmeric.
Mustard,	Double Superfine, . .	B. F. Fischer & Co., New York.	Large admixture of turmeric.
Mustard,	Victor, ...	Saville, Somes & Co., Boston, Mass.	Admixture of starch-containing weed seed.
Pepper, .	- -	Ragus Tea & Coffee Company, New York.	Admixture of foreign starch.
Pepper, .	- -	Ragus Tea & Coffee Company, New York.	Large admixture of wheat.

Tea.

Fifty samples were examined, all of which were genuine.

Vinegar.

Thirty-four samples were analyzed, of which 20 were condemned, either because they were found below the standard of total solids or of acid as fixed by law, or because in cases where they were sold for pure cider vinegar the analysis showed that this was untrue.

In addition to the cider vinegars, 3 samples of malt vinegar were examined, and pronounced of good standard quality.

Following is a summary of the results of analyses of 31 samples of cider vinegar found to be pure: —

Cider Vinegar Above Standard, 31 Samples.

	Acid (Per Cent.).	Solids (Per Cent.).	Ash (Per Cent.).	Polarization (200 mm. Ventzke).	Malic Acid Tests.	
					Lead Acetate.	Calcium Chloride.
Highest, ...	5.12	3.10	.42	—3.00	Positive, .	Positive.
Lowest, ...	4.50	2.10	.20	—0.60	Positive, .	Positive.
Average, ...	4.75	2.39	.31	—2.02	Positive, .	Positive.

The following table shows the results of analyses of 14 samples of vinegar below the standard: —

Cider Vinegar Below Standard, 14 Samples.

Acid (Per Cent.).	Solids (Per Cent.).	Ash (Per Cent.).	Polarization (200 mm. Ventzke).	Malic Acid Tests.	
				Lead Acetate.	Calcium Chloride.
5.70	0.98	.19	—0.5	Positive, . .	Positive.
5.12	1.60	-	—0.7	Positive, . .	Positive.
5.06	1.90	.25	—2.3	Positive, . .	Positive.
4.84	1.98	.20	—0.4	Positive, . .	Positive.
4.84	1.14	.18	—0.7	Positive, . .	Positive.
4.76	1.20	.28	—0.4	Positive, . .	Positive.
4.70	1.78	-	—1.4	Positive, . .	Positive.
4.68	1.90	.10	—1.1	Positive, . .	Positive.
4.68	1.46	.29	—1.1	Positive, . .	Positive.
4.64	1.98	.26	—2.0	Positive, . .	Positive.
4.59	1.84	-	—2.1	Positive, . .	Positive.
4.48	2.23	-	—1.6	Positive, . .	Positive.
4.44	2.08	.26	—2.7	Positive, . .	Positive.
4.43	2.40	-	—1.3	Positive, . .	Positive.

Following are the results of 5 samples bought for cider vinegar, but which proved not to be the product of pure apple juice, or not made exclusively from apple cider.

Cider Vinegar not the Exclusive Product of Pure Apple Juice, 5 Samples.

Acid (Per Cent.).	Solids (Per Cent.).	Ash (Per Cent.).	Polarization (200 mm. Ventzke).	Malic Acid Tests.		Color.
				Lead Acetate.	Calcium Chloride.	
5.04	3.05	-	+6.2	Positive, .	Positive, .	-
4.86	2.62	.14	+8.9	Positive, .	Negative, .	Caramel.
4.86	1.32	.28	—0.7	Negative, .	Negative, .	-
4.81	1.92	-	+3.1	Negative, .	Negative, .	-
4.42	1.38	.16	—0.8	Negative, .	Negative, .	Caramel.

Canned Goods.

Sixty-nine samples were examined, 6 of which were found to be not of good standard quality. Among the articles of this class examined were the following: beans, peas, corn, succotash, baked beans, mixed vegetables, pears, gage plums, blueberries, raspberries, peaches, strawberries, bacon, salmon, shrimp, mince meat; and the following soups: mock turtle, oxtail, consommé, chicken, mulligatawny.

Most of these were found to be of good standard quality, with the exception of the canned peas. The following brands of peas were found to be greened with copper. The product of Jules Dupont came under the variety known as soaked goods.

Published Results of Analyses of Canned Goods.

Variety.	Brand.	Manufacturer or Wholesaler.	Results of Analysis.
Peas, . .	Petits Pois, Extra Fins, .	Tisserand & Fils, . . .	Greened with copper.
Peas, . .	Petits Pois, Moyens, . .	Haskell Adams & Co., Boston,	Greened with copper.
Peas, . .	Petits Pois, Verts, . .	Nabob, Bordeaux, France, .	Greened with copper.
Peas, . .	Petits Pois, . . .	Alphonse Pinaud, Paris, .	Greened with copper.
Peas, . .	Petits Pois, . . .	Jules Dupont, ...	Greened with copper.

Miscellaneous Food.

One hundred and fifty-three samples of food not included in the classes hitherto mentioned were examined, 59 of which were found to be adulterated. Among the pure samples were included: beef extract, beer (2 samples), celery salt (2 samples), chewing gum, codfish, cooking oil, dried beef, evaporated apple (4 samples), flaxseed meal, grape juice, horseradish (2 samples), "jelly powder" (2 samples), milk powder, mince meat (4 samples), pastry spice, peanut butter (7 samples), pop corn cake, sage, sugar (2 samples), tripe, vegetable gluten.

The following miscellaneous foods examined call for more or less comment: —

Baking Powder. — Fifteen samples were examined, all of which were found to conform to the statute requiring the list of ingredients present.

Baking Soda. — Nine samples were examined, 1 of which was pronounced adulterated by reason of an excess of salt.

Cider. — Three samples of bottled sweet cider were analyzed, 2 of which were found to be preserved with benzoic acid. One of these bore no manufacturer's name; the other was labelled "Russet Cider," and was the product of the Copeland Farm Cider Mills of Milton.

Coffee Substitute. — Two samples were examined, one of which, labelled simply "Malt Coffee," evidently with the idea of conveying the impression that coffee was present, was condemned as containing no coffee.

Curry Powder. — Two samples were examined, one of which was found to contain rice starch as a filler.

Gluten Flour. — Two samples were analyzed, one of which, "Beardsley's Gluten Health Bread Flour, Entire Wheat," was found to be entire wheat flour with the normal percentage of starch, about 70 per cent., and the other sample was bulk goods, containing 63.7 per cent. of starch and 10.6 per cent. of protein. (See also "Vegetable Gluten" under "Drugs.")

Hamburg Steak. — Nineteen samples were analyzed, 17 of which were found to be preserved with a compound of sulphurous acid.

Jams and Jellies. — Thirty-five samples of these products were collected and analyzed, 24 of which were condemned as not conforming to the law. In most cases these products were the usual mixtures of apple stock and commercial glucose, either with or without varying proportions of cane sugar and of the genuine fruit which they purport to contain. The larger proportion were colored to conceal their inferior condition, and many were preserved with either benzoic or salicylic acid.

While many of these products have labels with the name and percentage of the ingredients, these labels are in many cases erroneous or misleading, or indistinct, so that they can by no means be considered in compliance with the law. Following is a list of jellies and jams published as adulterated during the year: —

Published Results of Analyses of Jams and Jellies.

Character of Sample.	Manufacturer.	Results of Analyses.
Raspberry preserve,	Logan, Johnson & Co., Boston, .	Salicylic acid and a coal tar dye. No formula.
Raspberry jam, .	Logan, Johnson & Co., Boston, .	Benzoic acid; not in formula.
Raspberry jam, .	Curtice Bros., Rochester, N. Y., .	Preserved with benzoic acid; amount of preservative not stated on formula.
Strawberry jam, .	P. J. Ritter Conserve Company, Philadelphia, Pa. "We guarantee the original contents of this bottle to be a pure and wholesome article of food."	Benzoic acid.
Strawberry jam, .	Ideal Preservative Company, Boston,	Benzoic acid; not in formula.

Ketchup. — Two samples only were examined, 1 of which was found preserved with benzoic acid.

Pickles. — Seven samples were analyzed, one of which was condemned as having been greened with copper salts.

"*N'egg.*" — This peculiar product, made by the Egg Substitute Company of Boston, was advertised by our Board many years ago, and it was thought had gone out of existence. It has again appeared upon the market during the present year.

It is claimed to be "the only genuine and nutritious substitute for eggs." It is put out in two boxes, one containing a white and the other a yellow powder, purporting to be "equivalent to the whites and yolks of one dozen eggs." As in the old days, the composition of the egg "white" was found to be nothing but tapioca starch; while that of the egg "yolk" was also tapioca starch, colored with a coal tar dye.

Wild Cherry Juice. — The single sample of this preparation examined was found to contain 17.48 per cent. by volume of alcohol. It was the product of the Beach & Clarridge Company of Boston.

Summary of Food Statistics, exclusive of Milk.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.		Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Allspice,	154	5	159	31.4	Flavoring extracts — *Concluded.*				
Butter,	209	8	217	3.7	Peppermint,	1	1	2	50.0
Canned goods,	63	6	69	8.7	Vanilla,	27	3	30	33.3
Cassia,	191	1	192	0.5	Ginger,	212	4	216	1.9
Cayenne,	50	-	50	0.0	Honey,	38	4	42	9.5
Cheese,	57	3	60	5.0	Lard,	16	9	25	36.0
Clover,	150	16	166	9.6	Mace,	19	12	31	38.8
Cocoa,	14	7	21	33.3	Maple sugar,	12	6	18	33.3
Coffee,	86	4	90	4.4	Maple syrup,	18	28	46	60.9
Condensed milk,	80	12	92	13.0	Miscellaneous,	100	48	148	32.4
Confectionery,	33	1	34	29.4	Molasses,	64	5	69	7.2
Cream of tartar,	264	6	270	1.7	Mustard,	195	31	226	11.6
Flavoring extracts: —					Nutmeg,	15	1	16	6.3
Almond,	20	4	24	16.6	Pepper,	333	13	346	3.8
Banana,	2	-	2	0.0	Tea,	50	-	50	0.0
Jamaica ginger,	0	1	1	100.0	Vinegar,	34	20	54	37.1
Lemon,	13	19	32	59.4	Totals,	2,521	278	2,799	9.9
Orange,	1	0	1	0.0					

Drugs.

The drugs collected and examined during the year were from much the same suspicious classes as in past years, namely, those which experience has shown most liable to adulteration. A full summary of the quality of the drugs examined will be found on page 337.

Aqua Destillata. — All 9 of the samples of distilled water collected from drug stores were found to vary widely from the requirements of the Pharmacopœia.

In this age, when the question of purity of our drinking water is so prominently brought before us, it is difficult to see why samples of pure distilled water are so rarely dispensed from the average drug store. In most cases the results of our analysis indicate that ordinary tap water has been sold under the guise of aqua destillata.

One of the worst samples examined in years by our department contained 25.5 parts of residue per 100,000. This sample was purchased in a Chelsea drug store. Another sample bought in Boston was found with 11 parts of residue per 100,000, and a third in Lowell with 8 parts per 100,000.

Bismuthi Subnitras. — A sample of this drug sold by a Vineyard Haven druggist to a summer resident caused serious illness. On analysis in this laboratory the powder was found to consist entirely of tartar emetic, evidently substituted by mistake. A sample of bismuth subnitrate was immediately after purchased by one of our inspectors of the same druggist, and found to be pure.

Calx Chlorata. — None of the samples of chlorinated lime were found to be of standard quality. The Pharmacopœia calls for 35 per cent. of available chlorine.

The product of Joseph Brookman & Sons of Chicago, Ill., was found to stand 67 per cent. of the required strength; that of the Acme White Lead and Color Works of Detroit, Mich., stood only at 3 per cent. of the required strength, consisting largely of calcium carbonate; the Hudson Chloride of Lime, manufactured by A. Mendelson & Sons, Albany, N. Y., stood at 29 per cent. of the required strength.

Essential Oils. — A larger variety than usual of these preparations were examined, as will be seen by the summary, including oils of cloves, cassia, wintergreen, lemon and peppermint. The optical examinations of the essential oils furnish by far the most convenient means of judging of their purity. Of greatest importance is the refractometric examination, which is applicable in all cases.

For this purpose we use the Abbé refractometer, furnished with temperature-controlling apparatus. Some of the oils, like lemon and peppermint, that rotate the plane of polarized light, are examined by the polariscope. The specific gravity also serves as a helpful test in many cases. Much work remains to be done on essential oils of known purity, especially as

regards their index of refraction, before perfectly satisfactory standards can be fixed.

The following constants were determined by H. C. Lythgoe on samples of essential oils obtained from Schimmel & Co., who were requested to furnish oils of known purity for the purpose of analysis for standards: —

Optical Constants of Some Essential Oils.

Oil.	Specific Gravity, 15°.	Polarization (100 mm. Degrees Ventzke).	n_D.				
			20°.	25°.	30°.	35°.	40°.
Peppermint,	0.9056	—79.7	1.4614	1.4593	1.4578	1.4553	1.4533
Peppermint,	0.9050	—77.8	1.4615	1.4594	1.4574	1.4554	1.4534
Sweet orange,	0.8510	272.8	1.4731	1.4708	1.4685	1.4662	1.4637
Bitter orange,	0.8532	266.6	1.4738	1.4715	1.4691	1.4667	1.4643
Citronella,	0.8996	—31.6	1.4813	1.4790	1.4768	1.4745	1.4722
Lemon grass,	0.9070	—10.0	1.4858	1.4836	1.4814	1.4792	1.4770
Spearmint,	0.9310	—126.4	1.4858	1.4836	1.4814	1.4792	1.4770
Cloves,	1.0502	—3.1	1.5313	1.5290	1.5268	1.5245	1.5222
Wintergreen (Betula),	1.1865	—0.1	1.5363	1.5340	1.5318	1.5295	1.5272
Wintergreen (Synthetic),	1.1865	0.0	1.5365	1.5342	1.5320	1.5297	1.5274
Cassia,	1.0666	0.7	1.5998	1.5973	1.5949	1.5925	1.5901
Cinnamon,	1.0395	—0.3	1.6029	1.6009	1.5988	1.5968	1.5948

Macis. — Two out of the 3 samples examined were found to consist wholly or in part of Bombay or wild mace.

Oleum Olivæ. — In 3 cases, samples of olive oil sold by druggists proved to consist almost entirely of cotton-seed oil.

Phenacetine. — Thirty-one samples were examined, 5 of which were found to be adulterated with acetanilid, and a number of court cases were brought for the sale of the adulterated article.

The method we most rely on to prove the presence of acetanilid consists in making a saturated aqueous solution of the sample in ice-cold water, and adding bromine water drop by drop to the clear solution in excess. If acetanilid is present, a white precipitate is formed on shaking. Another test consists in heating the sample with concentrated potassium hydroxide. If acetanilid is present, the odor of anilin is apparent, and on the addition of chloroform, the pungent odor of phenyl isocyanide is developed.

Sodii Boras. — Five samples out of the 17 examined consisted wholly or in part of sodium bicarbonate. The "Eclipse" brand of best refined borax, manufactured by M. J. and H. J. Meyer Company of New York, contained no borax whatever, being entirely sodium bicarbonate. The "Crescent" brand of C. L. Hirst & Co., New York, was largely sodium bicarbonate.

Spiritus Camphoræ. — Fifteen of the 22 samples examined were found to be low in strength. The following table shows the polarization and index of refraction of spirits of camphor of known strength, as made up in the laboratory with 95 per cent. alcohol. Lower refractions than those indicated in the table with this strength of alcohol would be suggestive of the presence of methyl alcohol.

Spirits of Camphor Standards.

Per Cent. of U. S. P. strength.	Polarization (200 mm. at 20°).	n_D at 35°.	Per Cent. of U. S. P. strength.	Polarization (200 mm. at 20°).	n_D at 35°.
0	0.0	1.3575	55	12.6	1.3633
5	1.0	1.3580	60	13.8	1.3638
10	2.1	1.3585	65	14.9	1.3644
15	3.2	1.3590	70	16.0	1.3650
20	4.4	1.3596	75	17.3	1.3655
25	5.4	1.3601	80	18.7	1.3660
30	6.5	1.3606	85	19.8	1.3665
35	7.7	1.3611	90	21.0	1.3670
40	8.9	1.3617	95	22.5	1.3675
45	10.2	1.3622	100	24.0	1.3680
50	11.4	1.3628			

Tinctura Iodi. — The usual high percentage of adulteration of this tincture was apparent, nearly 90 per cent. of those examined failing to conform to the Pharmacopœia. The quality of the samples collected is shown in the following statement: —

8	samples	were	between	90	and	95	per cent.	of the	United	States	pharmacopœial	strength.
46	"	"	"	80	"	90	"	"	"	"	"	"
45	"	"	"	70	"	80	"	"	"	"	"	"
12	"	"	"	60	"	70	"	"	"	"	"	"
5	"	"	"	50	"	60	"	"	"	"	"	"
2	"	"	"	40	"	50	"	"	"	"	"	"
2	"	"	"	30	"	40	"	"	"	"	"	"
-	"	"	"	20	"	30	"	"	"	"	"	"
3	"	"	"	10	"	20	"	"	"	"	"	"
1	"	"	"	5	"	10	"	"	"	"	"	"

Two samples of tincture of iodine were found to contain wood alcohol. One was purchased of Harry F. Weir, 322 Blue Hill Avenue, Roxbury; the other of F. A. Smith of Braintree. For our method of detecting wood alco hol see page 342.

The worst sample of tincture of iodine examined in this department for some years was purchased of Ira P. Jefts, 2224 Washington Street, Roxbury. This contained about 5 per cent. of the required amount of iodine.

Miscellaneous Drugs. — Under this heading are included, besides unclassified drugs, a number of the pharmacopœial preparations where only one or two samples of each were collected.

Among those analyzed and found pure were the following: aristol (4 samples), cera alba, epsom salts, oleum anisi, potassii bitartras, pulvis effervescens compositus, pulvis ipecacuanhæ et opii (3 samples), quinine pills (12 samples), sapo, sulphonal, tinctura capsici, tinctura zingiberis (2 samples), trional.

Samples classed as adulterated or below standard were the following: —

Cure for Alcoholism. — Manufactured by B. M. Wooley of Atlanta, Ga., was found to contain morphine.

Liquozone. — "Simply liquid oxygen," a product of the Liquozone Company of Chicago, was found to be a solution of 1.35 per cent. of sulphurous and 1.08 per cent. of sulphuric acid in water.

Opium Cure. — This product, put out by the St. James Society, 1183 Broadway, New York, was found to contain in 100 cubic centimeters .028 gram of caffeine and .085 gram of morphine.

Paw-Paw. — Munyon's Paw-Paw, manufactured by the Munyon Remedy Company of Philadelphia, and claiming to "do away with both the necessity and desire for beer, wine and whiskey," was found to contain 29.51 per cent. of alcohol by volume. It was also found not to contain any of the starch-converting enzymes of paw-paw.

Spiritus Gaultheriæ. — One sample was examined containing insufficient oil of wintergreen, and colored red with a coal tar dye. This was purchased in a Newburyport drug store.

Vegetable Gluten. — "Pure vegetable gluten," put out by the T. Metcalf Company of Boston, was found to be virtually whole wheat flour, and contained 63 per cent. of starch and 10.9 per cent. of protein.

Vinum Album and Vinum Rubrum. — One sample of each was examined, both below the standard.

Summary of Drug Statistics.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Æther,	1	2	3	66.6
Alcohol,	3	3	6	50.0
Aqua ammoniæ fortior,	2	9	11	81.8
Aqua destillata,	-	9	9	100.0
Calx chlorata,	-	9	9	100.0
Capsicum,	51	4	55	7.3
Caryophyllus,	8	-	8	0.0
Chloroformum,	5	1	6	16.6
Cinnamomum cassia,	6	-	6	0.0

Summary of Drug Statistics — Concluded.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Extractum glycyrrhizæ,	2	16	18	88.8
Extractum zingiberis fluidum,	5	0	5	0.0
Ferri et quininæ citras,	12	2	14	64.3
Ferrum reductum,	9	9	18	50.0
Glycerinum,	88	5	93	5.4
Macis,	1	2	3	66.6
Magnesii sulphas,	2	1	3	33.3
Miscellaneous,	45	16	61	26.2
Oleum caryophylli,	2	1	3	33.3
Oleum cinnamomi,	3	4	7	57.1
Oleum gaultheriæ,	3	-	3	0.0
Oleum limonis,	5	30	35	12.0
Oleum menthæ piperitæ,	2	1	3	33.3
Oleum morrhuæ,	22	7	29	24.2
Oleum olivæ,	27	3	30	10.0
Oleum ricini,	35	2	37	5.4
Opii pulvis,	1	1	2	50.0
Phenacetine,	26	5	31	16.1
Pulvis glycyrrhizæ compositus,	17	-	17	0.0
Quininæ sulphas,	3	-	3	0.0
Sinapis alba,	4	-	4	0.0
Sodii benzoas,	16	-	16	0.0
Sodii boras,	12	5	17	29.3
Sodii iodidum,	6	4	10	40.0
Sodii phosphas,	31	1	32	3.1
Spiritus ætheris nitrosi,	-	2	2	100.0
Spiritus camphoræ,	7	15	22	68.2
Spiritus frumenti,	-	7	7	100.0
Spiritus menthæ piperitæ,	3	-	3	0.0
Spiritus myrciæ,	12	-	12	0.0
Sulphur lotum,	2	10	12	83.3
Sulphur præcipitatum,	2	11	13	84.6
Sulphur sublimatum,	8	-	8	0.0
Syrupus,	-	3	3	100.0
Tinctura iodi,	15	128	143	89.5
Tinctura opii,	1	1	2	50.0
Tinctura opii camphorata,	5	-	5	0.0
Zingiber,	16	-	16	0.0
Totals,	526	329	855	38.5

Summary of Food and Drug Statistics for Year ending Sept. 30, 1904.

	Genuine.	Adulterated.	Total.	Per Cent. Adulterated.
Milk,	3,064	1,627	4,691	34.6
Food, exclusive of milk,	2,521	278	2,799	9.9
Drugs,	526	329	855	38.5
Totals,	6,111	2,234	8,345	26.7

Inspection of Liquors.

During the year ending Dec. 31, 1904, 238 samples of liquor were sent in for analysis by chiefs of police and other officers, in accordance with chapter 110 of the Acts of 1902. These samples came from 11 cities and 18 towns, the general character of the work done being summarized in the following table: —

Summary of Liquor Statistics.

	Number of Samples of Wine.	Number of Samples of Cider.	Number of Samples of Beer.	Number of Samples of Whiskey.	Number of Miscellaneous Samples.
Arlington,	-	1	-	-	-
Attleborough,	-	1	2	-	7
Avon,	-	2	-	-	-
Ayer,	-	-	1	-	-
Boston,	2	-	6	60	-
Brockton,	-	2	-	-	4
Cambridge,	1	-	2	-	1
Clinton,	2	11	15	-	-
Fall River,	-	-	1	-	-
Fitchburg,	5	1	8	-	2
Franklin,	-	-	7	-	-
Holliston,	-	-	4	5	-
Hyde Park,	-	1	-	-	-
Leominster,	6	1	1	5	-
Lowell,	-	-	3	-	-
Melrose,	-	2	-	-	-
Newton,	-	-	1	-	1
Norwood,	1	-	3	-	-
Peabody,	-	7	-	-	-
Pittsfield,	1	-	-	-	-
Quincy,	-	1	-	-	-
Randolph,	-	2	1	-	-
Revere,	-	-	14	-	-
Salem,	-	2	11	-	-
Swansea,	-	-	1	-	-
Wakefield,	5	3	-	-	1
Wareham,	3	-	-	-	2
Wellesley,	-	2	-	-	-
Winchendon,	-	2	-	-	-
Totals,	26	41	81	70	18

Deducting from the total the samples of whiskey, which were not sent in as a rule for purposes of prosecution, but because of the supposed existence of harmful adulterants, of the 173 samples of liquors remaining, 129, or about 75 per cent., were sold in no-license towns, and contained, on analysis, more than 1 per cent. of alcohol. The larger proportion of these were prosecuted; just how many, the analyst has no means of ascertaining, because in the larger number of these cases the analyst's certificate

of analysis is accepted as evidence, and he is not notified of the disposition of the case. This is not always true, however, and the analyst has been summoned into court during the year on cases brought for prosecution for liquor seized in the following places: Attleborough, Boston, Brockton, Clinton, Revere, Salem and Wakefield. Besides these, a number of appealed cases requiring personal attendance were brought in the superior courts of Norfolk, Plymouth and Suffolk counties.

Among the miscellaneous liquors examined were 7 samples of Jamaica ginger high in alcohol, sold as a beverage; 1 sample of essence of peppermint, also sold as a beverage, containing 60 per cent. of alcohol; 4 samples of rectified alcohol, ranging from 50 to 80 per cent. by volume; and a peculiar sample of "mixed liquors," seized in Cambridge. This latter sample was found in a kitchen bar-room, and at the time of the raid, the owner of the liquor, surprised by the advent of the officers, threw the bottle of whiskey into a pot containing corned beef and cabbage boiling upon the stove. The bottle naturally broke, and the resulting liquor that the officers seized and brought in for analysis was found to contain 5.78 per cent. of alcohol.

The purpose of the act which authorizes the Board of Health to analyze these liquors has been solely to establish the percentage of alcohol, as determining whether or not a liquor may be sold in a no-license locality.

A number of city and town authorities, filled with the popular belief that adulterated liquors contain poisonous ingredients, the effect of which was to greatly increase intemperance far in excess of that caused by pure liquor, have requested analyses for such poisons.

Highest authorities are agreed that nothing in whiskey exercises so marked toxic effects as the alcohols which they naturally contain; that there are no authentic instances on record of the presence in whiskies of substances more poisonous than the alcohols; that, while most of the whiskies are adulterated, the chief adulterants are water and sugar, with the result that as a matter of fact those liquors, weak in alcohol, are less potent from a temperance stand-point than are the pure liquors conforming to the standard of the Pharmacopœia.

A large number of samples of whiskey have been tested in this laboratory for wood alcohol, and in no case has this adulterant been found present. In this connection, 60 samples of the cheapest whiskey which the saloons of Boston could supply were sent in, by order of the police authorities; and, on account of the interesting nature and source of these liquors, an exception was made in this case, and a more complete analysis than usual of these samples was made.

Of the samples examined, all but 2 failed to conform to the required standard of the Pharmacopœia in amount of alcohol (50 to 58 per cent. by volume). As regards their content in alcohol, the liquors stood as follows: —

Samples containing from 50 to 55 per cent. alcohol,	2
Samples containing from 45 to 50 per cent. alcohol,	14
Samples containing from 40 to 45 per cent. alcohol,	40
Samples containing from 35 to 40 per cent. alcohol,	2
Samples containing from 30 to 35 per cent. alcohol,	1
Samples containing from 25 to 30 per cent. alcohol,	1
	60

Most of these liquors were found to be adulterated, but the chief adulterants were water and sugar, and no poisonous substances foreign to whiskey were found. In fact, a large proportion of the liquors were found to be of the so-called "blended" or "rectified" variety, made of cologne spirit colored with caramel, often watered, and containing in some cases such artificial fruit essences as œnanthic and pelargonic ethers, added for flavor. The "rectified" variety of whiskey often contains no fusel oil. Several samples contained raw or unaged whiskey, with notable traces of the fusel oil which exists in nearly all pure whiskey, even when aged. In fact, nothing was found in any of the samples more harmful than the alcohols which are found in the purest whiskey; and, as shown above, most of the samples were weak in alcohol. Every sample was carefully tested for the presence of wood alcohol, and no traces of this poisonous substance were found.

Respectfully submitted,

ALBERT E. LEACH,
Analyst.

A METHOD FOR THE DETECTION AND DETERMINATION OF METHYL ALCOHOL IN ALCOHOLIC SOLUTIONS.

By ALBERT E. LEACH and HERMANN C. LYTHGOE.

PRELIMINARY PAPER.

The use of wood alcohol in various preparations which come within the domain of the public analyst for examination is apparently on the increase. In Michigan, out of 160 samples of lemon extract examined during 1904, 56, or 35 per cent., were found to contain methyl alcohol in varying amounts. Besides these, methyl alcohol was found in Michigan in vanilla extract, wintergreen, peppermint, orange, almond, and various artificial fruit extracts. These, however, were for the most part put up by local Western manufacturers, and were brands not found on sale in Massachusetts.

In our own State, while we have found methyl alcohol in various pharmaceutical preparations for external use, such, for example, as tincture of iodine, we have found it in only two instances in food, viz., in orange and lemon extracts.

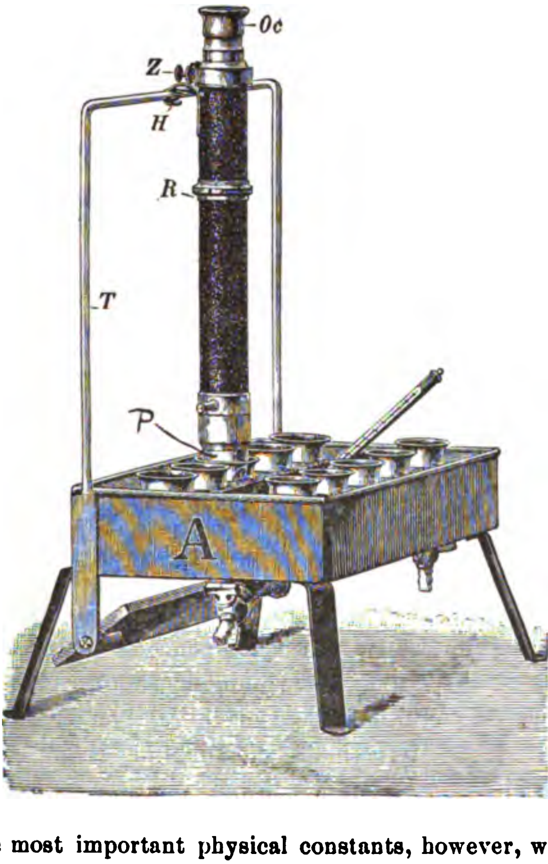
Existing methods for the detection of wood alcohol are, with one or two exceptions, unsatisfactory. Most of the older methods, such, for example, as the potassium permanganate test, depend upon the presence of acetone in the methyl alcohol. With the improved refining processes used at the present day, wood alcohol is readily obtainable free from more than traces of acetone. The most practical method hitherto used for the detection of methyl alcohol is that of Mulliken and Scudder,* which depends on the oxidation of the methyl alcohol in the sample to formaldehyde by the use of a red-hot spiral of copper wire, using the hydrochloric acid and milk test for the detection of the formaldehyde formed.

Methods for quantitative determination of wood alcohol are even more rare. Duprey† has suggested a method of concentrating the alcohol by repeated distillation, after which part of the final distillate is oxidized to acetic acid, the latter being titrated with alkali, while the alcohol is determined in the other portion of the distillate from the specific gravity. Both methods with pure ethyl alcohol should give concordant results,

* American Chemical Journal, 24 (1900) p. 444. † Analyst, I, 4.

whereas in the presence of methyl alcohol, a lower result is obtained by the oxidation process.

The specific gravity of absolute methyl and ethyl alcohol is practically identical, and it is also true that when mixed with varying proportions of water, the specific gravity of both alcohols is so nearly the same (with the same proportions of water in each) that the same tables for computation of percentage of alcohol from the specific gravity may be used in one case as in the other.



One of the most important physical constants, however, which we have found to differ most widely in the two alcohols, is the index of refraction; and it is on this property that we base our method for the detection and determination of methyl alcohol.

We use for this purpose the immersion refractometer of Zeiss, as shown in the accompanying figure. This is the same instrument used by us for the detection of watered milk as described in our report for 1903.

To illustrate the wide difference in refraction between the two alcohols, the strongest commercial ethyl alcohol found on the market (the alcohol

of the United States Pharmacopœia, which contains 91 per cent. of absolute alcohol by weight) gives a reading with the immersion refractometer of 98.3 at 20° C.; while the reading of methyl alcohol of 91 per cent. strength by weight is 14.9. Fifty per cent. ethyl alcohol by weight has a refraction on the immersion refractometer of 90.3; while the same strength (50 per cent.) of methyl alcohol refracts on the instrument at 39.8.

From this wide variation it is readily seen that there is no trouble in detecting even small amounts of methyl alcohol in mixtures. The following table shows the refractometer readings of varying strengths of both ethyl and methyl alcohol, all readings being made at 20°: —

Refraction of Ethyl and Methyl Alcohol.

[Scale of Zeiss immersion refractometer at 20° C.]

Per Cent. Alcohol by Weight.	Scale Reading.		Per Cent. Alcohol by Weight.	Scale Reading.		Per Cent. Alcohol by Weight.	Scale Reading.	
	Methyl Alcohol.	Ethyl Alcohol.		Methyl Alcohol.	Ethyl Alcohol.		Methyl Alcohol.	Ethyl Alcohol.
0	14.5	14.5	35	35.8	75.8	70	33.0	100.0
5	17.2	22.3	40	38.1	81.3	75	29.7	101.0
10	20.2	31.4	45	39.4	86.2	80	26.0	100.7
15	23.2	40.5	50	39.8	90.3	85	21.8	100.1
20	26.5	50.5	55	39.4	93.6	90	16.1	98.6
25	29.7	60.1	60	37.9	96.2	95	9.6	95.7
30	32.8	69.0	65	35.5	98.3	100	2.0	91.0

The difference in refraction between the two alcohols varies considerably for different strengths. In the case of methyl alcohol, starting at zero (or water containing no alcohol), at which the reading on the refractometer at 20° is 14.5, the refraction gradually increases with increasing strength of methyl alcohol up to about 50 per cent. of the latter by weight, where the refraction reaches its maximum, after which for higher strengths of methyl alcohol it drops quite rapidly, until at 100 per cent. the refraction is but 2.0.

In the case of ethyl alcohol, starting as before with pure water, and increasing the strength of the solution, the refraction increases quite rapidly up to solutions of about 75 per cent. strength, where it then drops slightly, but by no means to such an extent as in the case of wood alcohol. It will thus be seen that by far the widest variations in refraction between the two alcohols take place above 50 per cent. in strength.

The detection of wood alcohol by this method is comparatively simple, and consists simply in submitting to refraction by the immersion refractometer the distillate which one makes for the determination of ethyl alcohol in the regular manner in alcoholic beverages, essences, tinctures, extracts, or whatever may be the nature of the substance to be examined. If the refraction of the liquid shows the percentage of alcohol agreeing with that obtained from the specific gravity in the regular manner, it may safely be assumed that no methyl alcohol is present. If, however, an appreciable

amount of methyl alcohol is present, the low refractometer reading will at once indicate the fact. Not only can methyl alcohol be thus readily detected, but the amount may be approximately calculated. Addition of methyl to ethyl alcohol decreases the refraction in direct proportion to the amount present. Hence the quantitative calculation may be readily made by interpolation, using the figures for pure ethyl and methyl alcohol of the same alcoholic strength as the sample. The degree of accuracy of this calculation varies with the strength of alcohol. For instance, with an alcoholic strength of 10 per cent. there is less exactness than at 50 per cent. strength, where 1 per cent. of methyl can be readily determined. From this point on the delicacy of the process naturally increases, until at 90 per cent. strength .1 per cent. of methyl alcohol may be determined with accuracy.

The following table shows the readings on the immersion refractometer at 20°, corresponding to each percentage of alcohol from 1 to 50 by weight, all readings being taken at exactly 20° C. This table will show at a glance whether a solution of given strength of alcohol, as determined from the specific gravity, contains ethyl or methyl alcohol, or is a mixture of the two.

Scale Reading on Zeiss Immersion Refractometer Corresponding to Each Per Cent. of Methyl and Ethyl Alcohol from 0 to 50 Per Cent. 20° C.

Per Cent. Alcohol by Weight.	Scale Reading.		Per Cent. Alcohol by Weight.	Scale Reading.		Per Cent. Alcohol by Weight.	Scale Reading.	
	Methyl Alcohol.	Ethyl Alcohol.		Methyl Alcohol.	Ethyl Alcohol.		Methyl Alcohol.	Ethyl Alcohol.
0	14.5	14.5	17	24.5	44.5	34	35.2	74.4
1	14.8	16.0	18	25.2	46.5	35	35.8	75.8
2	15.4	17.6	19	25.8	48.5	36	36.3	76.9
3	16.0	19.1	20	26.5	50.5	37	36.8	78.0
4	16.6	20.7	21	27.1	52.4	38	37.3	79.1
5	17.2	22.3	22	27.8	54.3	39	37.7	80.2
6	17.8	24.1	23	28.4	56.3	40	38.1	81.3
7	18.4	25.9	24	29.1	58.2	41	38.4	82.3
8	19.0	27.8	25	29.7	60.1	42	38.8	83.3
9	19.6	29.6	26	30.3	61.9	43	39.2	84.2
10	20.2	31.4	27	30.9	63.7	44	39.3	85.2
11	20.8	33.2	28	31.6	65.5	45	39.4	86.2
12	21.4	35.0	29	32.2	67.2	46	39.5	87.0
13	22.0	36.9	30	32.8	69.0	47	39.6	87.8
14	22.6	38.7	31	33.5	70.4	48	39.7	88.7
15	23.2	40.5	32	34.1	71.7	49	39.8	89.5
16	23.9	42.5	33	34.7	73.1	50	39.8	90.3

REPORT

UPON THE

PRODUCTION, DISTRIBUTION AND USE OF DIPHTHERIA ANTITOXIN,

AND UPON BACTERIOLOGICAL DIAGNOSIS,

FOR THE

HALF YEAR ENDED SEPT. 30, 1904.

REPORT

UPON THE

PRODUCTION, DISTRIBUTION AND USE OF DIPHTHERIA ANTITOXIN

FOR THE

HALF-YEAR ENDED SEPT. 30, 1904.

The following report covers only the period from April 1, 1904, to Sept. 30, 1904, inclusive, the preceding six months having been included in the report for 1903. The change is made in order to secure uniformity in the periods covered by the reports of the various departments of the Board.

The production of diphtheria antitoxin has continued under the direction of Dr. Theobald Smith, at the Bussey Institute. The distribution has been conducted, as before, at the office of the Board.

The total number of packages issued by the Board during the nine years and six months ending with Sept. 30, 1904, was as follows: —

In 1895–1896 (year ending March 31),	1,724 bottles.
In 1896–1897 (year ending March 31),	3,219 bottles.
In 1897–1898 (year ending March 31),	4,668 bottles.
In 1898–1899 (year ending March 31),	12,491 bottles.
In 1899–1900 (year ending March 31),	31,997 bottles.*
In 1900–1901 (year ending March 31),	53,389 bottles.*
In 1901–1902 (year ending March 31),	40,211 bottles.*
In 1902–1903 (year ending March 31),	33,475 bottles.*
In 1903–1904 (year ending March 31),	41,133 bottles.*
During 6 months ending Sept. 30, 1904,	22,255 bottles.*
	244,562 bottles.

The reported cases of diphtheria in the State in the past six years (not deaths) were as follows: —

1899,	7,134	1902,	7,036
1900,	12,641	1903,	6,888
1901,	9,793	1904,	6,254

* These numbers have reference to the actual number of bottles issued in packages of about 1,500 units each. In order to make this comparable with the figures of the first three years (1895–1898), a package of 1,000 units should be employed as a standard, so that the 200,205 bottles distributed during the preceding five years would be equivalent to about 300,000 of the strength at first employed.

The total number of deaths from this cause in 1904 was 699, which is the smallest number in any year since 1870.

Death-rate from Diphtheria in Massachusetts, Forty-four Years (1861–1904).

Years.	Death-rate from Diphtheria per 10,000 Population.	Years.	Death-rate from Diphtheria per 10,000 Population.	Years.	Death-rate from Diphtheria per 10,000 Population.	Years.	Death-rate from Diphtheria per 10,000 Population.	Estimated Death-rate without Use of Antitoxin.
1861, . .	8.9	1872, . .	4.9	1883, . .	8.6	1894, . .	7.4	-
1862, . .	9.2	1873, . .	4.7	1884, . .	8.6	1895, . .	7.1	10.6
1863, . .	18.2	1874, . .	5.7	1885, . .	7.8	1896, . .	6.6	12.4
1864, . .	15.9	1875, . .	11.4	1886, . .	7.8	1897, . .	5.5	11.0
1865, . .	9.3	1876, . .	19.6	1887, . .	7.9	1898, . .	2.6	5.6
1866, . .	6.4	1877, . .	18.7	1888, . .	8.7	1899, . .	3.7	9.0
1867, . .	4.5	1878, . .	14.6	1889, . .	10.2	1900, . .	5.3	14.7
1868, . .	5.7	1879, . .	13.1	1890, . .	7.3	1901, . .	4.1	10.9
1869, . .	5.4	1880, . .	13.4	1891, . .	5.3	1902, . .	3.0	7.4
1870, . .	4.6	1881, . .	13.1	1892, . .	6.2	1903, . .	2.8	7.4
1871, . .	5.0	1882, . .	9.6	1893, . .	5.8	1904, . .	2.3	7.0

During the six months covered by this report, 922 cases of diphtheria were treated with the antitoxin furnished by the Board. An account was kept of the amount employed in each case, with the exception of six in which the figures were not obtainable, and the results are shown in the following table: —

Amount of Antitoxin Used.	Number of Cases.	Deaths.	Amount of Antitoxin Used.	Number of Cases.	Deaths.
Less than 1,000 units, . .	2	-	4,000 to 5,000 units, . .	100	7
1,000 to 1,500 units, . .	-	-	5,000 to 10,000 units, . .	169	3
1,500 to 2,000 units, . .	45	5	10,000 to 15,000 units, . .	123	3
2,000 to 3,000 units, . .	19	2	15,000 to 20,000 units, . .	93	4
3,000 to 4,000 units, . .	50	1	20,000 and more units, .	315	41

In 216 reported cases the amount of antitoxin administered was less than 5,000 units in each case, and in 700 reported cases the dose was 5,000 units or more. Of these latter, in 531 cases the dose was not less than 10,000 units, and in 315 cases it was not less than 20,000 units.

The serum was distributed to local boards of health, to hospitals, and to practitioners in 113 cities and towns, 21 of which used more than 100 bottles each. The following table shows the distribution: —

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1904, to Sept. 30, 1904.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Adams,	30	Easton,	6
Agawam,	60	Everett,	30
Amesbury,	6	Fall River,	175
Andover,	60	Fitchburg,	37
Arlington,	12	Foxborough,	18
Attleborough,	6	Framingham,	18
Bedford,	12	Franklin,	9
Beverly,	28	Georgetown,	6
Blackstone,	30	Gloucester,	100
Boston: —		Haverhill,	36
Children's Hospital,	701	Holbrook,	12
City Hospital,	10,578	Holyoke,	100
General supply,	2,887	Hopedale,	24
Massachusetts Charitable Eye and Ear Infirmary.	12	Hopkinton,	18
Massachusetts General Hospital,	30	Hull,	10
Massachusetts Homœopathic Hospital.	375	Burrage Hospital,	3
Saint Mary's Infant Asylum,	25	Huntington,	6
Schoolship "Enterprise,"	12	Hyde Park,	36
West End Nursery,	60	Lawrence,	325
Braintree,	24	Lenox,	6
Brockton,	137	Leominster,	6
Brookline,	200	Lexington,	6
Cambridge,	350	Lowell,	600
Hospital,	75	Ludlow,	9
Canton,	6	Lynn,	501
Chelsea,	187	Malden,	87
Cheshire,	6	Mansfield,	6
Chicopee,	24	Marblehead,	73
Clinton,	72	Marlborough,	25
Cohasset,	12	Maynard,	3
Colrain,	4	Medfield,	9
Concord,	24	Medford,	96
Danvers,	36	Medway,	24
Dedham,	6	Melrose,	36
Dighton,	18	Methuen,	27
Duxbury,	4	Milford,	48

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1904, to Sept. 30, 1904 — Concluded.

CITY OR TOWN.	Number of Bottles.	CITY OR TOWN.	Number of Bottles.
Millis,	10	Somerville,	800
Milton,	42	Southbridge,	197
Natick,	6	Spencer,	12
New Bedford,	300	Springfield,	275
Newburyport,	49	Stoneham,	18
Newton,	162	Stoughton,	18
North Adams,	270	Swampscott,	6
North Andover,	18	Taunton,	36
North Brookfield,	3	Topsfield,	12
Northampton,	12	Townsend,	6
Norton,	2	Wakefield,	36
Norwell,	12	Waltham,	36
Norwood,	61	Warren,	6
Palmer,	12	Wayland,	6
Peabody,	12	West Springfield,	86
Pittsfield,	112	Westfield,	6
Plymouth,	12	Weymouth,	54
Quincy,	118	Whitinsville,	6
Randolph,	12	Whitman,	24
Reading,	36	Wilbraham,	6
Revere,	55	Wilmington,	12
Rockland,	18	Winchester,	24
Rockport,	37	Winthrop,	6
Rowley,	6	Woburn,	12
Salem,	182	Worcester,	375
Saugus,	25	Total,	22,255
Scituate,	6		

SUMMARY OBSERVATIONS UPON THE USE OF DIPHTHERIA ANTITOXIN IN MASSACHUSETTS DURING THE SIX MONTHS ENDED SEPT. 30, 1904.*

The whole number of returns of cases treated with diphtheria antitoxin furnished by the State Board of Health during the six months ended Sept. 30, 1904, to hospitals and to local boards of health for use in general practice, was 1,162. Of this number, 922 were returns of cases of diphtheria

* The annual report for 1903 contains the data for the preceding six months.

treated with antitoxin, and 240 were returns of other persons who had been exposed to infection and were treated for the purpose of immunization. These cases constitute only a fraction of those which were treated during these six months in the State with antitoxin furnished by the Board, since very many physicians failed to make returns to the Board.

Cases in which a Bacterial Examination was made.

The same methods of classification are continued in this report as were adopted in the reports of the previous nine years. The cases in which cultures were made are classified into positive and negative cases. Diagnostic examinations were made in 838 cases reported to the Board as having been treated with antitoxin, and of these, 808 proved to be genuine cases of diphtheria and 30 gave a negative result.

Positive Cases.

Of the 808 positive cases, or those in which a diagnosis of diphtheria was made by bacterial cultures from the throat of the patient, there were 751 recoveries and 55 deaths, or 6.8 per cent.; the results of the previous years having been, respectively, 13.7, 11.6, 8.2, 7.9, 11.4, 9.4, 10.1, 9.8 and 8.1 per cent. In 2 cases, whether recovery or death was not stated.

Sex. — The number of males was 354, and the deaths of these were 28, or 7.9 per cent. The number of females was 452, and the deaths of these were 27, or 6 per cent. In 2 cases the sex was not stated.

Ages. — The following table shows the cases and deaths by ages: —

Six Months ended Sept. 30, 1904.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).	
			1904.	1903.
From 0 to 2 years,	57	9	15.8	25.8
From 2 to 5 years,	242	25	10.3	13.0
From 5 to 10 years,	280	16	5.7	5.9
Over 10 years,	206	5	2.4	2.4
Age unknown,	23	-	-	10.8
	808	55	6.8	8.1

Day of Illness when Antitoxin was first administered. — The following table presents the fatality, according to the day of illness on which the antitoxin was first administered: —

Day.	Cases.	Deaths.	Fatality (Per Cent.).									
			1904.*	1903.	1902.	1901.	1900.	1899.	1898.	1897.	1896.	1895.
First,	74	2	2.7	3.3	9.8	9.5	6.4	9.8	8.2	8.0	0.0	0.0
Second,	218	5	2.3	4.0	6.7	6.7	6.0	5.6	1.8	8.9	9.5	9.7
Third,	188	16	8.5	6.2	5.5	9.4	7.7	12.8	6.2	7.0	8.3	8.7
Fourth,	111	9	8.1	12.1	12.7	12.5	11.3	14.1	13.2	3.0	22.7	15.4
Fifth,	54	4	7.4	17.7	19.0	17.0	14.8	15.6	11.8	11.8	0.0	22.2
Sixth,	25	1	4.0	10.0	18.0	16.0	21.1	17.9	20.0	0.0	14.3	20.0
Seventh,	21	6	28.6	13.0	15.4	18.4	13.7	27.1	9.5	30.0	25.0	33.3†
Eighth and later,	48	4	8.3	8.5	17.8	18.5	16.8	14.7	10.4	13.6	16.6	-
Unknown,	69	8	-	-	-	-	-	-	-	-	-	-

* Six months only. † Seventh day and later.

The value of the foregoing table consists mainly in the definite statement of the fatality of cases according to the day of illness at which antitoxin treatment was begun. In general, it shows that the ratio of success in treatment depends largely upon the early date at which antitoxin is first administered. A fuller and more conclusive summary, embracing the whole period of nine years and six months, and containing greater numbers, may be found on a later page.

The cases in which antitoxin treatment was begun either upon the first, second or third days of illness constituted 59.4 per cent. of the whole number of positive cases reported to the Board to which antitoxin was administered during the six months under consideration.

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	724	49	6.8
In private practice,	84	6	7.1

Seasons of the Year. — The cases embraced in the foregoing enumeration occurred in the following order: —

Months.	Cases.	Deaths.	Months.	Cases.	Deaths.
1904.			1904.		
April,	144	8	August,	123	9
May,	184	15	September,	126	8
June,	135	8	Not stated,	1	-
July,	95	7		808	55

Negative Cases.

The reported cases in which a negative result was obtained were 30, and the deaths of these were 2, or 6.7 per cent.

Sex. — The males were 9, with 2 deaths, or 22.2 per cent.; and the females were 21, with no deaths.

Age. — The percentage of fatality at each of four age periods was as follows: 0 to 2 years, 7 cases, with no deaths; 2 to 5 years, 4 cases, with 1 death, or 25 per cent.; 5 to 10 years, 5 cases, with 1 death, or 20 per cent.; and all over 10 years, 14 cases, with no deaths.

Summary of the Nine Years and Six Months ended Sept. 30, 1904.

Positive Cases treated with Antitoxin.

Whole number of positive cases for the nine years and six months, 13,753; deaths, 1,316; fatality, 9.6 per cent.

Sex. — The fatality by sexes was as follows: —

Sex.	Cases.	Deaths.	Fatality (Per Cent.).
Males,	6,454	658	10.2
Females,	7,205	642	8.9
Not stated,	94	16	-

Ages. — The fatality by ages was as follows: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0 to 2 years,	1,434	318	22.2
2 to 5 years,	4,243	533	12.6
5 to 10 years,	4,063	283	7.0
Over 10 years,	3,561	125	3.5
Age unknown,	452	57	-

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	9,955	1,042	10.4*
In private practice,	3,786	274	7.2*
Not stated,	12	-	-

* This apparent difference in the fatality of hospital and of general or outside treatment with antitoxin is accounted for by the fact that a considerable number of severe and fatal cases of diphtheria, which were treated by physicians in general practice, were reported as having been transferred to a hospital after one or more days of home treatment, and died at the hospital.

Cases in which no Bacteriological Examination was made during the Six Months ended Sept. 30, 1904.

Reports were received of 84 cases where antitoxin was employed in which no cultures were taken. Of this number, 68, or 81 per cent., occurred in general practice, and the remainder were reported from hospitals. Of the whole number, 11 proved fatal, or 13.1 per cent.

Sex. — The number of males in this class was 36, and the deaths of these were 6, or 16.7 per cent. The number of females was 46, and the deaths of these were 5, or 10.9 per cent. The number of those whose sex was unknown or not stated was 2.

Age. — The following table presents the cases and fatality by ages among this class so far as observations were made: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
From 0 to 2 years,	5	2*	40.0
From 2 to 5 years,	28	8†	28.4
From 5 to 10 years,	27	-	-
Over 10 years,	24	1	4.2

* One case showed marked prostration.

† One case showed septic condition; 1 marked prostration, and 1 was moribund.

Sequelæ.

Temporary skin eruptions, usually of brief duration, are of very common occurrence after the administration of antitoxin. Frequently these eruptions are quite mild, and confined to a small area adjoining the place of injection, while occasional instances occur in which the eruption spreads throughout the entire surface of the body, or at least a portion of its area.

During the six months under consideration such eruptions or rashes are reported as occurring in 455 instances, or 49.3 per cent. of the whole number reported upon. Of this number, 95 per cent. were mild in character, and the remainder severe or extensive.

Albuminuria was reported in 38 instances, of which 35 were slight, or consisted of a trace only. The presence of albuminuria, however, has no significance as relating to the administration of antitoxin, since albuminuria is present, according to good authorities, in the majority of severe cases of diphtheria.*

Operations.

Tracheotomy, an operation which was once quite commonly resorted to in severe cases of laryngeal diphtheria, appears to have been largely supplanted by the more safe and simple operation of intubation. It is reported as having been performed 4 times, with 3 deaths.

* Osler's "Practice of Medicine," second edition, page 115.

Intubation is reported as having been performed 61 times, with 15 deaths, or 24.6 per cent.

The different diseases which are met with as complications of diphtheria independently of the use of antitoxin appear to depend for their frequency largely upon the relative prevalence of these diseases throughout the State. In the six months, April 1 to Sept. 30, 1904, scarlet fever was reported as a complication in 3 instances and measles in 2. During the year 1903 the figures were: for scarlet fever, 28; and for measles, 10 instances. In most cases the complication adds to the severity of the cases and increases the fatality, but not to so great an extent as when pneumonia supervenes. Pneumonia and broncho-pneumonia were reported as complications in 10 cases, 6 of which proved fatal.

The most important lesson, repeated in former reports, to which the experience of each successive year adds emphasis, is the necessity of the early administration of antitoxin in each and every case.

Immunization.

Returns of cases in which antitoxin had been used for the purpose of the immunization of persons who had been exposed to the infection of diphtheria were received in 240 cases. Of this number, 227 had been exposed to diphtheria, and had been immunized in the isolation wards of the Boston City Hospital, and chiefly in the scarlet-fever ward.

General Summary, 1895–1904.

Positive cases treated in the nine years and six months ended Sept. 30, 1904, and reported to the State Board of Health,	13,753
Cases in which no bacteriological examination was made,	3,358
Total,	17,111*
Deaths of these,	1,742
Fatality (per cent.),	10.2

Sexes.

The number of males who were treated was †	7,965
The number of females who were treated was †	8,975
The number whose sex was not stated was †	171
Total,	17,111*
Deaths of males,	865
Fatality of males (per cent.),	10.9
Deaths of females,	852
Fatality of females (per cent.),	9.5
Deaths, sex not stated,	25

* In this number (17,111), 1,593 cases in which a bacterial diagnosis showed negative results are not included, so that the whole number treated with antitoxin of which returns were made to the Board was 18,704.

† Except cases determined to be "negative."

The following table contains the results of those cases only which had been determined by a culture examination to be positive, with reference to the fatality of the disease in each group of cases, considered in relation to the stage of the disease when antitoxin was first administered.

Nothing can be more conclusive than the cumulative testimony of these figures, supported, as they are, by similar experience elsewhere, as to the importance of the earliest possible administration of antitoxin in the treatment of diphtheria. Each day's delay renders the liability to a fatal result greater.

The fatality of the cases which were treated with antitoxin very early in the course of the disease (that is, before the termination of forty-eight hours from its onset) was only 6.2* per cent., or 342 deaths in 5,483 cases; while that of the cases which were not thus treated until the sixth day or later was as high as 17 per cent., or nearly three times as great.

Day of Administration.

Day.	Cases.	Deaths.	Fatality (Per Cent.).
First,	1,627	120	7.4
Second,	3,856	222	5.8
Third,	3,150	274	8.7
Fourth,	1,996	251	12.6
Fifth,	1,037	162	15.6
Sixth and later,	1,466	244	16.6

A considerable number of cases and deaths, in which the day of administration was not stated in the returns, is excluded from this table.

* The sum of the experience of the first two days is expressed in this figure.

Report upon Diphtheria Cultures examined during the Half Year ended Sept. 30, 1904.

From April 1 to Sept. 30, 1904, 1,014 cultures were received from 98 towns and cities in the State. Of these cultures, 472 were for the purpose of diagnosis and 542 were for release from quarantine. The following table gives the number of cultures received from the different towns and cities and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Acton,	1	1	-	-	-
Andover,	5	3	2	-	-
Arlington,	17	3	6	1	7
Athol,	1	-	1	-	-
Attleborough,	5	2	2	-	1
Avon,	1	-	1	-	-
Barnstable,	40	8	4	1	27
Bedford,	1	-	1	-	-
Belchertown,	2	-	1	1	-
Bernardston,	7	-	-	-	7
Beverly,	8	2	3	-	3
Blackstone,	2	-	2	-	-
Boston,	1	-	1	-	-
Braintree,	6	2	3	-	1
Cambridge,	1	-	1	-	-
Canton,	2	-	-	-	2
Chelsea,	33	5	10	1	17
Clinton,	18	7	5	-	6
Cohasset,	9	2	3	-	4
Colrain,	1	-	1	-	-
Concord,	3	-	3	-	-
Danvers,	6	2	3	-	1
Dedham,	1	-	1	-	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Duxbury,	6	-	6	-	-
East Bridgewater,	1	-	1	-	-
Easton,	8	1	1	1	5
Everett,	34	5	10	-	19
Foxborough,	8	1	7	-	-
Framingham,	4	-	4	-	-
Haverhill,	3	1	-	2	-
Hingham,	2	-	2	-	-
Holbrook,	11	1	10	-	-
Hopkinton,	3	1	1	-	1
Hubbardston,	1	1	-	-	-
Hull,	1	1	-	-	-
Hyde Park,	14	-	5	-	9
Ipswich,	1	-	-	-	1
Lancaster,	1	1	-	-	-
Lawrence,	8	1	7	-	-
Littleton,	4	-	-	-	4
Lynn,	12	-	2	-	10
Lynnfield,	1	-	1	-	-
Malden,	59	7	5	1	46
Mansfield,	5	1	2	2	-
Marblehead,	31	9	10	-	12
Marlborough,	15	1	6	-	8
Medfield,	6	1	1	-	4
Medford,	58	9	21	-	28
Medway,	4	1	1	-	2
Melrose,	10	1	3	-	6
Methuen,	2	1	1	-	-
Milford,	1	-	1	-	-
Millis,	1	-	1	-	-
Milton,	23	3	8	-	12
Natick,	8	3	2	-	3
Needham,	2	-	2	-	-
Newbury,	14	1	2	-	11
Newburyport,	18	5	12	-	1
New Marlborough,	1	-	1	-	-
North Adams,	158	26	7	-	125
North Attleborough,	2	-	2	-	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Norwell,	1	-	1	-	-
Norwood,	1	-	-	1	-
Peabody,	22	2	2	-	18
Plymouth,	2	1	1	-	-
Princeton,	2	-	2	-	-
Quincy,	17	4	8	-	5
Randolph,	1	1	-	-	-
Reading,	6	2	3	-	1
Revere,	11	2	9	-	-
Rockland,	20	3	2	-	15
Rockport,	2	-	2	-	-
Salem,	62	3	11	1	47
Saugus,	12	1	10	-	1
Scituate,	3	-	1	-	2
Shirley,	4	-	4	-	-
Southbridge,	2	-	2	-	-
Stoneham,	1	-	1	-	-
Stoughton,	11	1	-	-	10
Swampscott,	5	2	-	-	3
Topsfield,	13	2	1	-	10
Townsend,	3	2	-	-	1
Wakefield,	11	2	5	-	4
Walpole,	2	1	1	-	-
Wareham,	1	-	1	-	-
Warren,	6	1	2	-	3
Watertown,	12	-	4	-	8
Wayland,	2	-	2	-	-
Westport,	1	-	1	-	-
Weymouth,	13	2	4	1	6
Williamsburg,	2	-	-	-	2
Williamstown,	1	-	1	-	-
Wilmington,	2	1	1	-	-
Winchendon,	1	-	-	-	1
Winchester,	37	6	10	-	21
Winthrop,	2	-	2	-	-
Woburn,	7	-	6	-	1
Wrentham,	1	-	1	-	-
Total,	1,014	159	300	13	542

Relation of Clinical to Bacteriological Diagnosis.

Of the 472 cultures taken for diagnosis, the relation of the clinical to the bacteriological diagnosis is as follows: —

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 131 cases,	75	51	5
Negative in 113 cases,	19	91	3
Doubtful in 126 cases,	32	91	3
Not given in 102 cases,	33	67	2
Total,	159	300	13

Relation of Bacteriological Diagnosis to the Day of taking the Culture.

Day of Disease on which Culture was taken.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
First day,	8	17	-
Second day,	52	86	2
Third day,	37	76	2
Fourth day,	17	30	2
Fifth day,	9	23	2
Sixth day,	6	9	2
Seventh day,	6	10	-
Over seven days,	16	19	2
Not stated,	8	30	1
Total,	159	300	13

Persistence of the Bacilli of Diphtheria in the Throats of Patients Convalescent from Diphtheria.

In 69 cases in which cultures were made at intervals of about a week, until a negative culture was obtained, the bacilli were last found on the days of the disease as indicated in the following table: —

Time of Persistence.	Number of Cases.	Time of Persistence.	Number of Cases.
8 days,	1	25 days,	2
9 days,	4	26 days,	5
10 days,	1	27 days,	1
11 days,	1	28 days,	1
12 days,	1	29 days,	2
13 days,	1	30 days,	2
14 days,	2	31 days,	4
15 days,	3	32 days,	2
16 days,	1	35 days,	2
17 days,	7	37 days,	1
18 days,	2	38 days,	1
19 days,	2	43 days,	2
20 days,	5	44 days,	1
21 days,	6	46 days,	1
22 days,	1	92 days,	2
23 days,	2		

Summary.

The whole number of cultures examined since the bacteriological diagnosis of diphtheria was undertaken is as follows: —

In 1896–1897 (year ended March 31, 1897),	1,469
In 1897–1898 (year ended March 31, 1898),	2,204
In 1898–1899 (year ended March 31, 1899),	1,591
In 1899–1900 (year ended March 31, 1900),	3,258
In 1900–1901 (year ended March 31, 1901),	5,173
In 1901–1902 (year ended March 31, 1902),	4,119
In 1902–1903 (year ended March 31, 1903),	2,904
In 1903–1904 (year ended March 31, 1904),	3,632
From April 1 to Sept. 30, 1904,	1,014
Total,	25,364

Of these 25,364 cultures, 11,455 were made for the purpose of diagnosis and 13,909 for release from quarantine. Of the cultures made for diagnosis, 4,692, or about 41 per cent., were positive, 6,573 were negative, and 190 were doubtful.

REPORT UPON EXAMINATIONS OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

From April 1 to Sept. 30, 1904, microscopical examination has been made of 494 lots of sputum and other material suspected of containing the bacilli of tuberculosis. This material has been received from 93 different cities and towns in the State. The following table gives the places from which the material has been received and the results of the microscopical examinations:—

City or Town.	Whole Number of Examinations.	Primary Examinations.			City or Town.	Whole Number of Examinations.	Primary Examinations.		
		Positive.	Negative.	Doubtful.			Positive.	Negative.	Doubtful.
Acton,	1	1	-	-	Concord,	3	2	1	-
Adams,	4	3	1	-	Concord, Massachusetts Reformatory.	13	5	8	-
Andover,	1	-	1	-	Danvers,	5	2	3	-
Arlington,	3	1	2	-	Dedham,	8	2	6	-
Ashland,	6	4	2	-	Edgartown,	1	-	1	-
Athol,	2	2	-	-	Everett,	18	10	8	-
Attleborough,	4	1	3	-	Fall River,	51	29	22	-
Barnstable,	1	1	-	-	Foxborough,	3	1	2	-
Bedford,	1	1	-	-	Framingham,	5	1	4	-
Berkley,	2	2	-	-	Franklin,	1	-	1	-
Beverly,	1	-	1	-	Freetown,	2	2	-	-
Blackstone,	2	-	1	1	Great Barrington,	5	1	3	1
Boston,	6	5	1	-	Greenfield,	1	1	-	-
Braintree,	6	4	2	-	Groton,	1	1	-	-
Bridgewater,	5	2	3	-	Haverhill,	1	1	-	-
Brookline,	1	-	1	-	Hingham,	3	-	3	-
Cambridge,	2	1	1	-	Holbrook,	4	2	2	-
Chatham,	1	1	-	-	Hyde Park,	12	3	9	-
Chelsea,	11	6	5	-	Ipswich,	5	2	3	-
Clinton,	4	2	2	-	Lawrence,	7	4	3	-

City or Town.	Whole Number of Examinations.	Primary Examinations.			City or Town.	Whole Number of Examinations.	Primary Examinations.		
		Positive.	Negative.	Doubtful.			Positive.	Negative.	Doubtful.
Lexington,	6	2	4	-	Reading,	6	-	6	-
Lincoln,	1	-	1	-	Revere,	8	3	5	-
Littleton,	5	5	-	-	Rockland,	6	4	2	-
Lynn,	3	2	1	-	Salem,	12	6	6	-
Malden,	11	8	3	-	Scituate,	3	2	1	-
Mansfield,	10	6	4	-	Shelburne,	3	1	2	-
Marion,	1	1	-	-	Sherborn,	1	1	-	-
Marlborough,	4	-	4	-	Shirley,	2	1	1	-
Medford,	6	1	5	-	Spencer,	2	-	2	-
Medway,	1	1	-	-	Swansea,	2	-	2	-
Melrose,	9	3	6	-	Taunton,	19	11	7	1
Middleton,	2	1	1	-	Topsfield,	2	1	1	-
Milford,	2	-	2	-	Wakefield,	7	2	5	-
Millis,	1	-	1	-	Walpole,	4	2	2	-
Milton,	2	1	1	-	Warren,	1	-	1	-
Montague,	1	1	-	-	Watertown,	1	-	1	-
Natick,	10	3	7	-	Wellesley,	2	-	2	-
Needham,	5	1	4	-	Westford,	3	1	2	-
New Bedford,	1	1	-	-	Whitman,	2	1	1	-
Newburyport,	1	1	-	-	Williamstown,	2	1	1	-
North Adams,	25	10	15	-	Winchendon,	2	-	2	-
North Attleborough,	10	4	6	-	Winchester,	6	1	5	-
Northfield,	1	1	-	-	Winthrop,	2	1	1	-
Norwood,	4	2	2	-	Woburn,	7	1	6	-
Peabody,	15	3	12	-	Worthington,	2	-	2	-
Plymouth,	3	-	3	-	Wrentham,	2	-	2	-
Quincy,	31	9	22	-	Total,	494	213	278	3
Randolph,	1	-	1	-					

Ages. — The relation of bacteriological diagnosis to age is shown in the following table: —

Age Periods.	Number of Cases examined.	Positive.	Negative.	Doubtful.
From 0 to 10 years,	10	1	9	-
From 10 to 20 years,	75	39	36	-
From 20 to 30 years,	160	81	78	1
From 30 to 40 years,	105	45	59	1
From 40 to 50 years,	53	17	36	-
From 50 to 60 years,	40	12	28	-
From 60 to 70 years,	16	4	12	-
From 70 to 80 years,	11		8	-
Age not stated,	24	11	12	1
Total,	494	213	278	3

Sex. — The relation of bacteriological diagnosis to sex is shown in the following table: —

Bacteriological Diagnosis.	Total.	Males.	Females.	Sex not stated.
Positive cases,	213	106	98	9
Negative cases,	278	132	141	5
Doubtful cases,	3	2	1	-
Total,	494	240	240	14

Clinical Diagnosis. — The relation of bacteriological to clinical diagnosis is as follows: —

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 188 cases,	103	83	2
Negative in 76 cases,	22	54	-
Doubtful in 109 cases,	34	75	-
Not given in 121 cases,	54	66	1
Total 494 cases,	213	278	3

Duration of Disease. — The relation of bacteriological diagnosis to the duration of the disease is shown below: —

Duration of Disease to the Time of Examination of Sputum.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
1 month or less,	18	25	-
1 to 2 months,	29	35	-
2 to 3 months,	20	29	-
3 to 6 months,	39	42	-
6 to 9 months,	12	6	-
9 to 12 months,	19	14	-
1 to 2 years,	18	14	2
Over 2 years,	8	20	1
Not given,	50	93	-
Total,	213	278	3

Summary.

The number of specimens of sputum and other material examined for the bacilli of tuberculosis since the undertaking of these examinations is as follows: —

In 1896–1897 (year ended March 31, 1897),	124
In 1897–1898 (year ended March 31, 1898),	236
In 1898–1899 (year ended March 31, 1899),	414
In 1899–1900 (year ended March 31, 1900),	571
In 1900–1901 (year ended March 31, 1901),	746
In 1901–1902 (year ended March 31, 1902),	797
In 1902–1903 (year ended March 31, 1903),	928
In 1903–1904 (year ended March 31, 1904),	1,006
In 1904 (from April 1 to September 30),	494
Total,	5,316

Of these 5,316 specimens, 2,123, or 39.9 per cent., contained the bacilli of tuberculosis, in 3,135 specimens the bacilli were not found, and in 58 specimens no bacteriological diagnosis was made.

TYPHOID FEVER.

Widal, Agglutinative or Serum Test.

During the six months ended Sept. 30, 1904, 204 specimens of blood were subjected to the widal or agglutinative test for typhoid fever, the method employed being substantially the same as that described in the report for 1900. The dilution used corresponds to 1 part by weight of fluid blood to 20 of a bouillon culture of typhoid bacilli, or 1 part of blood serum to about 35 of culture fluid.

The blood specimens examined are given in the two following tables. In the first they are grouped according to towns. The whole number of specimens received is given, and divided into positive and negative, according to the outcome of the test. Sixty-one towns sent specimens to the laboratory, of which 46 were positive and 158 negative.

In the second table the results of the examination are arranged according to the day of the disease on which the blood was collected. From this table it will be seen that positive cases were most numerous after the sixth day of the disease. Since the agglutination-reaction may not appear until the second week of the disease, or even later, the blood of cases examined with negative result during the first week should be again examined in the second or third week.

Widal Test, April 1, 1904, to Sept. 30, 1904.

City or Town.	Number of Cases.	Positive.	Negative.	City or Town.	Number of Cases.	Positive.	Negative.
Arlington,	2	-	2	Lawrence,	2	1	1
Attleborough,	5	2	3	Leominster,	4	1	3
Barnstable,	1	-	1	Lincoln,	1	1	-
Bedford,	1	-	1	Lynn,	22	4	18
Beverly,	3	-	3	Malden,	1	-	1
Boston,	1	1	-	Marlborough,	4	2	2
Brewster,	2	-	2	Marshfield,	1	-	1
Cambridge,	3	-	3	Medford,	4	-	4
Concord,	3	-	3	Melrose,	4	-	4
Cottage City,	1	-	1	Milton,	2	1	1
Chelsea,	4	1	3	Natick,	1	-	1
Clinton,	1	-	1	Needham,	3	1	2
Danvers,	3	1	2	Newton,	2	-	2
Duxbury,	1	-	1	Newburyport,	13	2	11
Everett,	9	2	7	Peabody,	1	-	1
Foxborough,	1	1	-	Pepperell,	1	-	1
Haverhill,	2	1	1	Plymouth,	1	-	1
Hingham,	1	-	1	Randolph,	7	4	3
Holden,	4	1	3	Reading,	12	1	11
Hyde Park,	2	-	2	Revere,	3	2	1

Widal Test, April 1, 1904, to Sept. 30, 1904 — Concluded.

City or Town.	Number of Cases.	Positive.	Negative.	City or Town.	Number of Cases.	Positive.	Negative.
Rockport, . .	2	-	2	Wayland, . .	1	-	1
Salem, . . .	5	2	3	Wellesley, . .	2	1	1
Scituate, . . .	2	-	2	Westport, . .	2	-	2
Somerville, . .	9	3	6	Weymouth, . .	1	-	1
Southborough, .	1	-	1	Williamstown, .	4	2	2
Stoughton, . .	1	-	1	Winchester, . .	8	3	5
Swampscott, . .	3	-	3	Winthrop, . .	4	1	3
Taunton, . .	1	-	1	Woburn, . .	1	-	1
Topsfield, . .	1	-	1				
Waltham, . .	4	2	2	Total, . .	204	46	158
Watertown, . .	13	2	11				

Widal Test, according to Stage of Disease, April 1, 1904, to Sept. 30, 1904.

Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.		Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.	
	Positive.	Negative.		Positive.	Negative.
3, ...	1	4	24, ...	-	1
4, ...	2	2	26, ...	-	2
5, ...	2	11	27, ...	-	1
6, ...	2	5	28, ...	-	1
7, ...	6	9	29, ...	-	1
8, ...	5	12	30, ...	1	-
9, ...	1	8	31, ...	-	1
10, ...	2	11	32, ...	-	3
11, ...	1	5	33, ...	-	2
12, ...	1	7	34, ...	-	2
13, ...	1	4	35, ...	-	2
14, ...	6	13	37, ...	-	2
15, ...	-	3	44, ...	1	-
16, ...	1	1	53, ...	-	1
17, ...	1	1	74, ...	-	1
18, ...	2	3	84, ...	-	1
19, ...	-	3	90, ...	-	1
20, ...	-	3	Unknown, ...	5	25
21, ...	5	3			
22, ...	-	2	Total, ...	46	158
23, ...	-	1			

MALARIA.

The number of blood films received by the laboratory during the six months ended Sept. 30, 1904, for microscopic diagnosis, was 24, of which only 3, or 12.5 per cent., showed the malaria parasite.

Malaria, April 1, 1904, to Sept. 30, 1904.

City or Town.	Number of Cases.	Positive.	Negative.
Arlington,	1	-	1
Concord,	3	-	3
Marshfield,	1	-	1
Melrose,	2	1	1
Quincy,	2	1	1
Reading,	1	-	1
Somerville,	2	-	2
Swampscott,	1	-	1
Uxbridge,	1	-	1
Westford,	1	-	1
Winchester,	9	1	8
Total,	24	3	21

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the recent reports of the Board, been presented under four different heads or groups. In the reports of 1902, 1903 and 1904 this series of statistics has been condensed as much as can be done consistently with a clear and intelligent method of presentation.

These summaries are defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They serve principally to show the seasonal prevalence of each of the chief infectious diseases, and the mortality of children under five years old, in weekly periods. Beginning with the year 1875, this series of statistics has been annually reported (see page 475 of report for that year), and was first published as a summary in the report of 1883.

II. *The Reports of Certain Infectious Diseases, — Diphtheria and Croup, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the annual reports of local boards of health for the year 1904, which are forwarded to the State Board from cities and towns. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy. This summary was first presented in the report of 1891, page 878.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III. This summary was first published in the report of 1893, page 639.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. The population of these cities

and towns in 1904 constituted about 85 per cent. of the estimated total population of the State. These reports are made under the requirements of the following statute :—

In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the State Board of Health. The form of such reports shall be prescribed and furnished by the State Board of Health. (Revised Laws, chapter 75, section 12.)

This summary was first presented in the report of 1894.

NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

I.

The Weekly Mortality Returns.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year 1904. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty-five years or more, and also as a publication of the Board, in a weekly bulletin, since and including 1883.

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of a portion only of the population, the reporting places being chiefly the cities and large towns.

The estimated population of the cities and towns contributing to these returns in 1904 was 2,135,416, or 68 per cent. of the estimated total population.

The following items are embraced in this summary: —

Average height of barometer for each week.
Mean maximum temperature.
Mean minimum temperature.
Rainfall, expressed in inches.
Total deaths reported for each week.
Deaths of children under five years.
Deaths from consumption.
Deaths from acute lung diseases.
Deaths from typhoid fever.
Deaths from diphtheria and croup.
Deaths from scarlet fever.
Deaths from measles.
Deaths from diarrhœal diseases.
Deaths from whooping-cough.
Deaths from puerperal fever.
Deaths from malarial fever.
Deaths from erysipelas.
Deaths from cerebro-spinal meningitis.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

Summary for 1904.

1904.	Barometer.	Maximum Mean Thermometer for Each Week.	Minimum Mean Thermometer for Each Week.	Humidity.	Rainfall, in Inches.*	Total Deaths.	Deaths under Five Years of Age.	Consumption.	Acute Lung Diseases.	Typhoid Fever.	Diphtheria and Croup.	Scarlet Fever.	Measles.	Diarrhœal Diseases.	Whooping-cough.	Puerperal Fever.	Malarial Fever.	Erysipelas.	Cerebro-spinal Meningitis.
Jan. 2,	29.98	25	9	71	-	666	177	52	108	7	7	4	1	7	8	2	-	3	3
9,	30.08	22	9	76	-	735	110	62	131	9	23	8	2	6	1	-	-	2	6
16,	29.78	36	23	81	-	700	227	74	134	6	17	6	4	11	3	-	-	3	8
23,	30.22	28	11	82	-	676	161	79	135	4	12	4	3	8	1	2	-	4	2
30,	30.22	29	14	69	4.39	657	179	61	112	5	10	4	2	10	2	-	-	4	6
Feb. 6,	29.99	32	13	66	-	615	149	64	106	1	8	6	2	3	1	1	-	4	5
13,	30.19	29	9	72	-	639	163	57	124	6	13	3	1	8	-	1	-	3	5
20,	30.09	26	11	73	-	693	191	63	123	4	18	2	7	13	-	-	-	4	5
27,	30.03	37	20	68	2.88	679	185	75	130	4	8	3	2	10	2	-	-	4	2
March 5,	30.27	35	21	75	-	700	189	78	131	10	12	2	14	7	1	-	-	6	3
12,	29.63	40	23	64	-	715	171	79	116	7	9	4	6	11	2	1	-	2	6
19,	29.97	38	26	66	-	730	197	72	134	5	13	6	10	5	1	1	-	3	5
26,	30.06	54	35	68	2.93	739	175	77	132	5	9	3	4	6	2	1	-	3	4
April 2,	30.15	43	34	71	-	724	197	76	119	5	8	3	8	12	2	1	-	3	6
9,	30.08	52	36	62	-	751	191	74	133	4	11	2	3	11	-	-	-	7	6
16,	29.83	51	36	62	-	641	176	67	114	1	9	3	6	13	4	-	-	7	4
23,	30.09	52	32	60	-	706	188	87	123	3	11	2	2	17	2	1	-	4	8
30,	29.94	57	43	83	7.10	672	192	72	100	5	7	1	8	15	3	1	-	5	2
May 7,	30.19	69	48	56	-	720	198	84	98	3	6	3	7	14	1	-	-	6	4
14,	30.00	66	52	84	-	681	176	76	94	4	7	1	3	9	2	3	-	4	2
21,	29.85	62	49	78	-	593	122	79	70	4	10	1	4	14	1	-	-	3	4
28,	29.95	79	58	63	3.24	491	119	54	61	6	7	-	2	13	-	-	-	2	3
June 4,	30.10	66	53	80	-	523	133	69	47	3	7	1	1	7	-	-	-	-	6
11,	30.05	68	52	86	-	518	141	56	52	6	7	1	3	10	1	-	-	-	4
18,	29.99	70	54	63	-	440	114	51	40	3	6	2	4	18	2	-	1	2	6
25,	29.96	82	61	65	3.96	548	152	67	43	4	14	-	5	25	-	-	-	1	3
July 2,	29.96	78	63	79	-	512	157	54	29	6	4	1	3	30	2	-	-	1	2
9,	30.10	75	64	77	-	500	126	55	26	2	7	1	2	33	-	-	-	-	5
16,	29.90	81	64	78	-	587	182	63	47	3	6	-	4	77	2	-	-	1	6
23,	29.91	79	65	67	-	651	262	63	31	7	5	-	4	118	3	-	-	-	3
30,	30.11	79	63	77	2.60	710	342	50	40	3	9	1	4	201	2	-	-	1	6
Aug. 6,	30.00	79	65	84	-	705	344	52	33	7	8	-	1	145	-	-	-	1	6
13,	30.15	74	61	71	-	726	317	49	22	6	5	-	1	187	3	-	-	-	5
20,	29.96	78	62	78	-	687	296	43	26	11	3	-	2	179	3	-	-	2	4
27,	30.07	78	59	71	3.76	597	258	53	25	11	5	-	-	125	-	-	-	1	3

Sept. 3,	30.13	77	59	71	-	623	251	55	25	7	6	-	-	124	2	-	-	-	1
10,	30.14	70	55	77	-	608	221	60	33	6	6	2	-	98	5	2	-	-	3
17,	30.10	73	55	80	-	648	258	70	44	9	10	2	-	92	1	-	-	-	4
24,	30.23	67	48	68	4.68	641	249	46	51	8	9	3	-	74	2	1	-	-	5
Oct. 1,	29.83	66	55	77	-	629	210	73	48	8	10	-	-	69	1	2	1	-	5
8,	30.12	59	42	68	-	551	178	54	42	15	5	1	1	57	1	-	-	2	6
15,	30.12	59	43	81	-	524	154	56	51	12	15	-	-	33	-	-	-	-	4
22,	30.00	67	48	67	-	597	149	62	53	8	8	-	2	27	2	-	-	1	2
29,	30.17	55	38	67	1.86	550	156	51	58	7	17	-	-	19	1	-	-	2	4
Nov. 5,	30.13	50	35	63	-	558	157	44	70	8	12	1	1	22	-	-	-	-	2
12,	29.89	45	30	65	-	566	126	65	71	7	10	-	3	19	-	-	-	1	6
19,	30.07	43	28	66	-	561	134	47	77	8	13	1	-	13	-	-	-	1	-
26,	29.82	47	34	68	1.83	610	158	58	112	14	10	1	2	11	2	-	-	-	3
Dec. 3,	30.07	37	22	66	-	659	171	76	99	18	15	3	2	19	2	-	-	1	6
10,	29.91	27	19	69	-	605	137	56	89	11	11	3	1	1	-	1	-	4	6
17,	30.11	28	15	69	-	655	162	51	117	11	15	3	-	11	1	1	-	1	6
24,	29.98	39	20	71	-	617	146	62	101	4	18	3	1	11	2	-	-	3	5
31,	29.97	35	22	64	2.97	630	155	56	121	4	16	-	-	11	1	1	-	2	4
Totals,	-	-	-	-	42.20	33,404	9,819	3,324	4,246	345	517	100	148	2,089	75	23	2	114	225
Weekly average,	-	-	-	-	-	630	185	63	80	6.5	9.7	1.9	2.8	39.4	1.4	.4	.04	2.1	4.2
Rate per 1,000 deaths,	-	-	-	-	-	-	293.9	99.5	127.1	10.3	15.5	3.0	4.4	62.5	2.3	.69	.06	3.41	6.74
Rate per 1,000 population,	-	-	-	-	-	15.64	4.60	1.56	1.99	.16	.24	.05	.07	.98	.04	.01	.0009	.053	.11

Average reporting population, ... 2,135,416

* Rainfall in inches. The figures in this column are given in months instead of by weeks.

Condensed Statistics, embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts in 1904.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	33,404	630	100.00	15.64
Deaths under five years,	9,819	185	29.39	4.60
Deaths from consumption,	3,324	63	9.95	1.56
Deaths from acute lung diseases,	4,246	80	12.71	1.99
Deaths from typhoid fever,	345	6.5	1.03	0.16
Deaths from diphtheria and croup,	517	9.7	1.55	0.24
Deaths from scarlet fever,	100	1.9	0.30	0.05
Deaths from measles,	148	2.8	0.44	0.07
Deaths from diarrhœal diseases,	2,089	39.4	6.25	0.98
Deaths from whooping-cough,	75	1.4	0.23	0.04
Deaths from puerperal fever,	23	0.4	0.069	0.01
Deaths from malarial fever,	2	0.04	0.006	0.0009
Deaths from erysipelas,	114	2.1	0.341	0.053
Deaths from cerebro-spinal meningitis,	225	4.2	0.674	0.11

The usual observations upon the weekly mortality statistics are omitted, and the foregoing short table, containing the essential statistics, supplies their place. The omission is made because information of the same character is presented in a different form in Section IV. of these summaries. The chief difference consists in the fact that the information given in this section (I.) is entirely voluntary and is detailed by weeks, while that of Section IV. is required by statute, the data not being forwarded to the Board until after the close of the year. The population which furnishes the statistics presented in Section IV. is considerably larger than that embraced in Section I., but both populations consist of the more densely settled parts of the State.

Meteorology.

The principal points of sanitary interest in the meteorology of Massachusetts for the year 1904 were the following: —

The mean temperature of the year in the State was 45.1° F.

The mean temperature of the summer months of June, July, August and September was as follows: June, 63.6°; July, 69.7°; August, 65.3°; September, 60.6°.

The annual rainfall was 42.2 inches, or a little below the average of a series of years.

II.

Fatality of Certain Diseases.

The following statement presents the statistics gathered from the published reports of local boards of health relative to the numbers of the cases and the deaths from each one of certain notifiable diseases. Its object is to present the fatality of these diseases (ratio of deaths to cases) from year to year. The complete statistics of reported cases are given in Section III.

The diseases embraced in this summary in 1904 are diphtheria, scarlet fever, typhoid fever and measles.

The tabular list of cities and towns is omitted in this report. The summary of the figures for 1904 is as follows: —

Reported cases of diphtheria and croup,	6,254
Registered deaths from diphtheria and croup in the same cities and towns,	577
Fatality (per cent.),	9.2
Reported cases of scarlet fever,	3,441
Registered deaths from scarlet fever in the same cities and towns,	109
Fatality (per cent.),	3.2
Reported cases of typhoid fever,	2,426
Registered deaths from typhoid fever in the same cities and towns,	410
Fatality (per cent.),	16.9
Reported cases of measles,	11,662
Registered deaths from measles in the same cities and towns,	163
Fatality (per cent.),	1.4

The following table presents the summary of these statistics for the fourteen years 1891–1904: —

Reported Cases of Infectious Diseases in Massachusetts.

Diphtheria and Croup.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria and Croup.

[Antitoxin Period.]

	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total 1895-1904.
Reported cases, . .	7,856	8,915	7,856	3,843	6,540	12,578	8,921	5,848	5,319	6,254	73,880
Deaths, . . .	1,484	1,348	1,107	507	758	1,274	938	666	592	577	9,251
Fatality (per cent.), .	18.9	15.1	14.1	13.2	11.6	10.2	10.5	11.4	11.1	9.2	12.5

Scarlet Fever.

	1903.	1904.	Total 1891-1904.
Reported cases, ...	4,911	3,441	71,980
Deaths, ...	387	109	4,050
Fatality (per cent.), ...	7.8	3.2	5.6

Typhoid Fever.

Reported cases, ...	2,594	2,426	34,598
Deaths, ...	363	410	6,161
Fatality (per cent.), ...	14.0	16.9	17.8

Measles.

Reported cases, ...	8,166	11,662	109,629
Deaths, ...	149	163	1,436
Fatality (per cent.), ...	1.8	1.4	1.3

In the foregoing tables the statistics relating to diphtheria and croup have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1904) it was 12.5 per cent., or less than half as large.

III.

Official Returns of Notified Diseases Dangerous to the Public Health, 1904.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year 1904, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except smallpox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: smallpox, scarlet fever, measles, typhoid fever, diphtheria, membraneous croup, cholera, yellow fever, typhus fever, cerebro-spinal meningitis, hydrophobia, malignant pustule, leprosy, trichinosis.

The whole number of cases of infectious diseases reported to the Board in 1904, under the provisions of this act was 26,088, which were divided as follows: —

Reported cases of smallpox,	100
Reported cases of scarlet fever,	4,100
Reported cases of diphtheria and croup,	6,772
Reported cases of typhoid fever,	2,605
Reported cases of measles,	12,511
Total,	26,088

The summary for the eleven years and four months 1893–1904 is as follows: —

	Reported Cases of — Smallpox.	Scarlet Fever.	Diphtheria and Croup.	Typhoid Fever.	Measles.	Total.
1893 (four months only),	35	2,914	1,109	1,525	1,503	7,086
1894,	181	6,731	4,178	2,372	2,133	15,595
1895,	1	6,194	7,806	2,488	4,868	21,807
1896,	5	3,801	8,515	2,637	6,362	21,320
1897,	18	5,495	7,613	2,104	12,695	27,925
1898,	10	3,667	3,960	2,196	4,478	14,331
1899,	105	5,349	7,134	2,776	12,355	27,719
1900,	104	6,396	12,641	2,967	10,507	32,615
1901,	778	4,356	9,793	2,689	9,398	27,009
1902,	2,314	4,613	7,036	2,721	17,249	33,933
1903,	422	5,877	6,888	2,955	9,430	25,572
1904,	100	4,100	6,772	2,605	12,511	26,088
Total,	4,068	59,493	83,465	29,985	103,489	280,500

By months these diseases were reported as follows: —

Cases of Infectious Diseases reported to the State Board of Health by Months in 1904.

Months.	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Months.	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
January, . .	5	604	794	148	1,363	August, . .	23	129	352	305	77
February, . .	5	544	548	111	2,365	September, .	46	172	523	437	47
March, . .	3	449	583	111	2,293	October, . .	3	294	716	450	135
April, . . .	1	426	524	119	1,965	November, . .	–	328	684	265	235
May, . . .	8	280	458	166	1,813	December, . .	–	465	687	209	436
June, . . .	3	237	555	114	1,198	Total, . .	100	4,100	6,772	2,605	12,511
July, . . .	3	172	398	170	584						

The following table is introduced for the purpose of facilitating the comparison of the seasonal prevalence of the diseases named in the table, in different years. By means of the method employed, the errors due to the difference in the length of the months are eliminated. The figures should be read as follows: for example, the mean daily number of reported cases of diphtheria reported throughout the year in 1904 was 18.5; of scarlet fever, 11.2; of typhoid fever, 7.1; and of measles, 34.2. During the month of January the mean daily number of reported cases of these diseases was, for diphtheria, 25.6; scarlet fever, 19.5; typhoid fever, 4.8; and for measles, 44.0 (see columns marked A).

Assuming a standard of 10 as a daily mean throughout the year for each disease, the ratios for January were as follows: diphtheria, 13.8; scarlet fever, 17.4; typhoid fever, 6.8; and measles, 12.9 (see columns marked B). So that for each 10 cases of diphtheria reported as a daily mean throughout the year 1904 there were 13.8 in January, 10.2 in February, 9.3 in March, etc.

From this table it appears that the maximum prevalence of diphtheria in 1904 was in January and the minimum in August. The prevalence in the last three months in the year was greater than that of the first three months. There has been in every one of the past ten years a decline in the prevalence of the disease in December, except in December, 1899.

The prevalence of scarlet fever was above the mean in January, February, March, April and December, and below it in the remaining months, the maximum occurring in January and the minimum in August. In the previous year the maximum was in May and the minimum in September.

Typhoid fever was, as usual, below the mean in the intensity of its prevalence in the first seven months of 1904, rising to a maximum in September.

In 1904, as in 1901, 1902 and 1903, the intensity of its prevalence in September and October was nearly equal.

The prevalence of measles was much above the mean in the first half of the year and below it in the last half, the maximum occurring in February and the minimum in September.

Certain Infectious Diseases. Seasonal Intensity of Prevalence.

Months.	Diphtheria.			Scarlet Fever.			Typhoid Fever.			Measles.		
	1904.		1903.	1904.		1903.	1904.		1903.	1904.		1903.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.
January, .	25.6	13.8	11.0	19.5	17.4	12.9	4.8	6.8	7.8	44.0	12.9	15.9
February, .	18.9	10.2	10.4	18.8	16.8	12.3	3.8	5.4	5.9	81.6	23.9	18.1
March, . .	17.2	9.3	7.9	14.5	12.9	12.2	3.6	5.1	5.3	74.0	21.6	17.6
April, . .	17.5	9.5	6.8	14.2	12.7	11.1	4.0	5.6	4.4	65.5	19.2	14.9
May, . .	14.8	8.0	8.5	9.0	8.0	13.4	5.4	7.6	6.8	58.5	17.1	14.6
June, . .	18.5	10.0	8.0	7.9	7.1	12.7	3.8	5.4	7.5	39.9	11.7	11.6
July, . .	12.8	6.9	6.7	5.5	4.9	6.9	5.5	7.7	8.9	18.8	5.5	4.3
August, . .	11.4	6.2	6.9	4.2	3.8	5.5	9.8	13.8	17.7	2.5	0.7	1.9
September, .	17.4	9.4	7.6	5.7	5.1	5.0	14.6	20.6	16.1	1.6	0.5	0.9
October, . .	23.1	12.5	16.3	9.5	8.5	7.2	14.5	20.4	17.4	4.4	1.3	3.2
November, .	22.8	12.3	15.3	10.9	9.7	8.3	8.8	12.4	13.7	7.8	2.3	7.1
December, .	22.2	12.0	14.3	15.0	13.4	12.5	6.8	9.6	8.2	14.1	4.1	10.1
Mean, .	18.5	10.0	10.0	11.2	10.0	10.0	7.1	10.0	10.0	34.2	10.0	10.0

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-nine Cities and Towns during 1904.

	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.		Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
Abington, . .	-	17	3	-	4	Amherst, . .	-	1	2	-	16
Acton, . . .	-	8	3	1	27	Andover, . .	-	23	33	12	-
Acushnet, . .	-	2	1	-	-	Arlington, . .	-	75	21	7	31
Adams, . . .	3	3	12	10	-	Ashburnham, .	-	-	3	-	-
Agawam, . .	-	1	23	-	-	Ashfield, . .	-	-	-	1	-
Amesbury, . .	-	74	3	7	1	Ashland, . .	-	3	-	-	-

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-nine Cities and Towns during 1904 — Continued.

	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.		Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
Athol,	-	1	2	1	3	Clinton,	-	16	19	1	5
Attleborough,	-	17	16	5	30	Cohasset,	-	-	11	1	5
Auburn,	-	6	-	-	-	Colrain,	-	-	1	-	-
Avon,	-	2	-	-	44	Concord,	-	10	11	3	6
Ayer,	-	11	2	1	-	Dalton,	-	10	-	-	-
Barnstable,	-	4	7	4	510	Dana,	-	-	1	-	-
Barre,	-	7	1	-	5	Danvers,	-	9	5	-	1
Becket,	-	-	4	-	-	Dartmouth,	-	2	-	1	-
Bedford,	-	-	12	3	-	Dedham,	-	8	2	5	26
Bellingham,	-	2	2	-	-	Deerfield,	-	11	1	-	5
Belmont,	-	8	2	-	17	Dighton,	-	2	16	-	-
Berlin,	-	1	-	2	-	Douglas,	-	-	-	1	-
Bernardston,	-	-	5	-	-	Dracut,	-	3	15	-	2
Beverly,	1	10	22	21	8	Dudley,	-	-	1	2	-
Billerica,	-	1	14	-	-	Dunstable,	-	2	-	-	-
Blackstone,	-	-	3	-	-	Duxbury,	-	3	-	1	45
Boston,	-	1,026	2,596	888	4,488	East Bridgewater,	-	2	-	1	129
Boxborough,	-	1	-	-	-	Easthampton,	-	-	3	11	-
Boylston,	-	1	-	-	-	East Longmeadow,	-	3	-	-	-
Braintree,	-	30	5	5	160	Easton,	-	-	3	2	-
Brewster,	-	-	-	1	-	Essex,	-	2	-	1	4
Bridgewater,	-	-	-	1	37	Everett,	-	69	46	22	134
Brockton,	-	70	33	43	1,771	Fairhaven,	-	8	2	3	2
Brookfield,	-	1	3	1	-	Fall River,	-	98	117	79	1
Brookline,	-	29	35	15	108	Falmouth,	-	1	-	-	4
Cambridge,	-	137	339	139	474	Fitchburg,	3	12	12	12	31
Canton,	-	-	2	3	18	Foxborough,	-	5	3	6	-
Carlisle,	-	3	-	-	1	Framingham,	-	15	11	1	3
Charlton,	-	-	-	2	-	Franklin,	-	6	18	-	-
Chatham,	-	1	-	-	-	Freetown,	-	3	1	-	-
Chelmsford,	-	18	24	2	14	Gardner,	1	4	32	3	-
Chelsea,	-	50	80	41	226	Georgetown,	-	3	3	-	-
Cheshire,	-	-	13	1	-	Gill,	-	2	-	-	7
Chester,	-	-	1	11	-	Gloucester,	-	16	78	7	7
Chicopee,	-	33	33	12	5	Grafton,	-	2	-	-	-

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-nine Cities and Towns during 1904 — Continued.

	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.		Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
Granville,	-	-	-	-	6	Lowell,	4	131	288	47	433
Great Barrington,	-	1	9	-	-	Ludlow,	-	2	-	-	-
Greenfield,	-	33	4	5	7	Lynn,	-	73	139	61	70
Groton,	-	1	-	-	-	Malden,	-	65	88	61	549
Groveland,	-	9	1	3	-	Manchester,	-	1	1	1	-
Hadley,	-	-	1	-	-	Mansfield,	-	42	3	6	2
Hanover,	-	5	3	3	25	Marblehead,	-	23	16	4	8
Hardwick,	-	16	6	5	2	Marlborough,	-	27	29	6	67
Harvard,	-	14	-	5	-	Marshfield,	-	1	-	-	8
Harwich,	-	5	-	-	12	Mashpee,	-	-	-	1	-
Hatfield,	-	1	2	1	3	Mattapoisett,	-	1	-	-	3
Haverhill,	-	22	37	59	305	Maynard,	-	3	1	2	-
Hingham,	-	6	3	-	-	Medfield,	-	1	3	-	1
Holbrook,	-	8	4	2	23	Medford,	-	40	35	23	147
Holden,	-	18	1	10	3	Medway,	-	5	1	-	3
Holliston,	-	3	3	-	-	Melrose,	-	18	13	7	68
Holyoke,	-	20	119	21	33	Mendon,	-	1	3	-	-
Hopedale,	-	6	4	1	-	Merrimac,	-	4	4	-	1
Hopkinton,	-	-	4	-	2	Methuen,	-	34	19	10	6
Hubbardston,	-	8	-	2	-	Middleborough,	-	8	1	3	-
Hudson,	-	2	7	16	-	Middleton,	-	1	1	-	-
Huntington,	-	-	1	-	-	Milford,	1	18	13	4	1
Hyde Park,	-	21	12	3	55	Millbury,	-	12	1	-	-
Ipswich,	-	2	7	19	23	Millis,	-	-	1	-	-
Lakeville,	-	1	-	-	-	Milton,	-	13	20	9	64
Lancaster,	-	1	3	-	-	Monroe,	2	1	4	-	-
Lawrence,	10	58	102	63	198	Monson,	-	1	-	-	3
Lee,	4	9	-	-	-	Montague,	-	1	1	6	-
Leicester,	-	1	-	-	-	Nahant,	-	-	-	1	-
Leominster,	5	9	3	5	2	Natick,	-	1	-	-	-
Lexington,	-	5	6	-	4	Needham,	-	6	2	2	9
Leyden,	-	-	-	-	3	New Bedford,	-	55	73	55	37
Lincoln,	-	2	-	1	-	Newbury,	-	-	6	2	1
Littleton,	-	11	-	-	1	Newburyport,	-	13	28	21	142
Longmeadow,	-	8	2	-	-	Newton,	-	101	80	38	80

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-nine Cities and Towns during 1904 — Continued

	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
North Adams,	61	30	141	24	193
Northampton,	-	3	5	16	117
North Andover,	-	3	4	3	6
No. Attleborough,	-	2	-	-	2
Northborough,	-	11	-	2	4
Northbridge,	-	16	15	6	3
North Brookfield,	-	1	-	1	-
Northfield,	-	1	3	1	1
North Reading,	-	1	1	-	-
Norton,	-	20	-	-	2
Norwell,	-	-	1	2	-
Norwood,	-	9	47	10	62
Oakham,	-	2	-	-	1
Orleans,	-	-	1	-	-
Otis,	-	-	-	1	-
Palmer,	-	5	9	14	5
Paxton,	-	-	1	-	-
Peabody,	-	9	16	5	4
Pelham,	-	-	-	-	1
Pembroke,	-	-	-	-	8
Pepperell,	-	8	-	-	47
Pittsfield,	5	33	56	11	2
Plymouth,	-	17	2	40	62
Princeton,	-	2	-	1	-
Provincetown,	-	-	9	-	-
Quincy,	-	35	73	5	108
Raynham,	-	3	-	-	-
Reading,	-	7	4	8	4
Rehoboth,	-	6	-	-	-
Revere,	-	14	42	3	-
Rockland,	-	9	5	7	10
Rockport,	-	4	28	-	-
Rowley,	-	2	3	2	1
Russell,	-	1	-	-	-
Salem,	-	26	88	23	31

	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
Salisbury,	-	-	-	4	6
Sandisfield,	-	-	1	-	-
Sandwich,	-	-	-	-	72
Saugus,	-	6	26	2	22
Scituate,	-	-	1	-	-
Seekonk,	-	-	1	1	-
Sharon,	-	-	1	1	17
Sheffield,	-	8	-	1	87
Shirley,	-	-	2	-	5
Shrewsbury,	-	3	-	2	2
Shutesbury,	-	4	-	-	-
Somerset,	-	-	5	-	-
Somerville,	-	114	334	78	246
Southampton,	-	5	3	3	-
Southborough,	-	2	-	-	-
Southbridge,	-	-	148	2	-
South Hadley,	-	19	3	5	5
Spencer,	-	1	21	1	-
Springfield,	-	112	247	77	44
Stockbridge,	-	4	-	1	-
Stoneham,	-	3	7	-	2
Stoughton,	-	15	9	4	13
Stow,	-	3	-	-	1
Sturbridge,	-	-	1	-	-
Sudbury,	-	-	-	-	1
Sutton,	-	-	1	1	1
Swampscott,	-	6	6	1	2
Swansea,	-	-	3	-	-
Taunton,	-	41	27	1	-
Templeton,	-	5	13	1	-
Tewksbury,	-	-	9	3	3
Tisbury,	-	-	-	2	1
Topsfield,	-	-	3	-	-
Townsend,	-	-	3	1	7
Truro,	-	-	-	1	-

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-nine Cities and Towns during 1904 — Concluded.

	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.		Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
Tyringham, . .	-	-	-	-	4	Westminster, .	-	2	1	2	-
Upton, . . .	-	1	-	2	1	West Newbury, .	-	1	2	-	-
Uxbridge, . .	-	30	-	1	1	Weston, . .	-	2	-	1	2
Wakefield, . .	-	9	6	11	65	Westport, . .	-	2	2	1	12
Walpole, . .	-	7	1	-	-	West Springfield, .	-	7	55	1	-
Waltham, . .	-	54	48	33	32	Westwood, . .	-	2	-	-	-
Ware, . . .	-	20	3	-	-	Weymouth, . .	-	11	14	5	46
Wareham, . .	-	-	6	-	-	Whitman, . .	-	12	4	-	41
Warren, . .	-	32	4	-	1	Wilbraham, . .	-	2	4	-	5
Watertown, . .	-	19	13	4	32	Williamsburg, .	-	-	1	-	-
Wayland, . .	-	1	-	-	-	Williamstown, .	-	9	5	2	-
Webster, . .	-	15	7	-	-	Wilmington, . .	-	3	-	3	-
Wellesley, . .	-	19	3	1	3	Winchendon, .	-	4	4	5	7
Westborough, .	-	3	1	5	1	Winchester, . .	-	6	15	4	33
West Boylston, .	-	-	-	1	-	Winthrop, . .	-	8	5	14	9
West Brookfield, .	-	3	-	-	-	Woburn, . .	-	19	16	6	1
Westfield, . .	-	8	33	11	5	Worcester, . .	-	150	108	103	64
Westford, . .	-	-	1	5	2	Yarmouth, . .	-	-	-	-	53
Westhampton, .	-	-	1	-	3	Total, . .	100	4,100	6,772	2,605	12,511

Anthrax occurred in the following place: —

Lynn, ...	1

Glanders occurred in the following places: —

Chelsea, ...	1
Fall River, ...	1
Total, ...	2

Leprosy occurred in the following places: —

Boston, ...	2
Harwich, ...	1
Total, ...	3

List of Cities and Towns from which no Reports were received.

I. Cities.

None.

II. Towns having a Population of More than 5,000.

Orange. — 1.

III. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Belchertown,	Hinsdale,	Oxford,
Dennis,	Hull,	Rutland,
Hamilton,	Nantucket,	Sterling. — 9.

IV. Towns having Less than 1,000 Inhabitants.

Alford,	Halifax,	Plympton,
Ashby,	Hampden,	Prescott,
Berkley,	Hancock,	Richmond,
Blandford,	Hawley,	Rochester,
Bolton,	Heath,	Rowe,
Boxford,	Holland,	Royalston,
Brimfield,	Lanesborough,	Savoy,
Burlington,	Leverett,	Sunderland,
Chesterfield,	Lynnfield,	Tolland,
Chilmark,	Marion,	Tyngsborough,
Clarksburg,	Middlefield,	Wales,
Cummington,	Monterey,	Warwick,
Dover,	Montgomery,	Washington,
Eastham,	Mt. Washington,	Wellfleet,
Egremont,	New Ashford,	Wendell,
Erving,	New Braintree,	Wenham,
Florida,	New Salem,	West Tisbury,
Gay Head,	Norfolk,	Whately,
Goshen,	Peru,	Windsor,
Gosnold,	Petersham,	Worthington. — 64.
Granby,	Phillipston,	
Greenwich,	Plainfield,	

The following towns sent notice to the Board that no infectious diseases had been reported within their limits during the year 1904: —

Bourne,	Enfield,	Shelburne,
Buckland,	Hanson,	Sherborn,
Carver,	Kingston,	Southwick,
Charlemont,	Lenox,	West Bridgewater,
Conway,	Lunenburg,	West Stockbridge,
Cottage City,	New Marlborough,	Wrentham. — 20.
Edgartown,	Randolph,	

A supply of postal cards for the purpose of reporting infectious diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the secretary of the State Board, Room 141, State House, Boston.

IV.

Official Returns of Deaths in Cities and Large Towns (Revised Laws, Chapter 75, Section 12).

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year 1904 comprise nearly the same list as that of 1903. This list embraces all of the 33 cities and the towns having more than 5,000 inhabitants in each.

As the estimated population of Easton for 1904 is over 5,000, a return was sent in by that town, this being the first time it has appeared in the list. Reading has also voluntarily contributed returns of deaths to the Board during the past seven years, although not required by law to do so.

The return from the town of Montague is made for the first time, although the local authorities have repeatedly been requested to submit returns in accordance with the requirements of the statute. This year the Board made repeated requests, which were ignored; and a communication was forwarded, stating that, unless immediate attention was paid to the requests, application would be made for a writ of mandamus. Finally, the matter was placed in the hands of the Attorney-General, and preparations were made to summon the delinquents; but proceedings were stopped by the receipt of the desired statistics.

The list for the year 1904 includes 95 cities and towns. In order to allow for the growth of population, and hence to arrive at a fairly accurate estimate of the death-rates of these cities and towns, an estimate of the population of each city and town in 1904 has been made, this estimate being based upon the rate of growth between the two census years 1895 and 1900.

The total estimated population of this group of cities and towns in 1904 was 2,638,585, or about 85 per cent. of the estimated total population of the State in that year.

The whole number of registered deaths in these towns in 1904 was 40,806, and the death-rate, as calculated from the foregoing estimated population, was 15.47 per 1,000 of the living population, that of the previous year having been 16.14 per 1,000, and that of 1902 16.21 per 1,000.

These were not only the lowest death-rates of this reporting population observed during the ten years since the enactment of the law requiring

these returns, but they were also considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

Sexes. — The number of deaths of males was 20,593, or 50.47 per cent. of the whole number of deaths whose sex was known; and the deaths of females were 20,207, or 49.53 per cent. There were 6 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows: —

Ages.	Deaths. 1904.	Percentages of All Deaths. 1904.	Percentages of All Deaths. 1903.	Ages.	Deaths. 1904.	Percentages of All Deaths. 1904.	Percentages of All Deaths. 1903.
Under 1 year, .	8,707	21.35	21.38	20 to 50 years, .	10,200	25.01	24.36
1 to 20 years, .	5,534	13.57	15.39	50 and over, .	16,350	40.08	38.86

Infant Mortality. — The deaths of infants under one year old were 8,707, or 21.34 per cent. of the total mortality, as compared with 21.38 per cent. in 1903; and this was the lowest rate of infant mortality during the period of eleven years since the law was enacted requiring these returns; that of the five years 1900–1904 respectively constituted 23, 21.6, 21.7, 21.38 and 21.34 per cent. of the total mortality.

The deaths of children under five years old were 11,841, or 29 per cent. of the total mortality, as compared with 29.7 per cent. for the same age in 1903.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 15; in 1903 it was 44.

Still-births. — The number of still-births was 2,716, and when compared with the total mortality (still-births included), this was 6.2 per cent. of the total deaths and still-births combined. In 1903 the percentage was 6.3.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths. 1904.	Percentages. 1904.	Percentages. 1903.
First quarter, ...	11,076	27.14	27.23
Second quarter, ...	9,675	23.71	23.75
Third quarter, ...	10,318	25.29	26.09
Fourth quarter, ...	9,734	23.86	22.93
Total, ...	40,803	100.00	100.00

These percentages differ but little from the mean of several years, which usually shows the highest mortality in the third quarter of the year. In 1899, 1901, 1903 and 1904 the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 382 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

	Deaths in Each Month.	Mean Daily Deaths per Month. 1904.*	Centesimal Ratio.			Deaths in Each Month.	Mean Daily Deaths per Month. 1904.*	Centesimal Ratio.	
			1904.*	1903.				1904.*	1903.
January, . .	3,751	121.0	108.5	108.4	August, . .	3,601	116.2	104.2	105.1
February, . .	3,458	119.1	106.8	113.9	September, .	3,364	112.1	100.5	98.0
March, . .	3,872	124.9	112.0	109.3	October, . .	3,091	99.7	89.4	88.3
April, . .	3,629	121.0	108.5	105.7	November, .	3,200	106.7	95.7	86.8
May, . . .	3,311	106.8	95.8	96.3	December, . .	3,443	111.1	99.6	97.6
June, . . .	2,735	91.2	81.8	83.7	Annual mean,	-	111.5	100.0	100.0
July, . . .	3,353	108.2	97.0	107.3					

* In ascertaining the mean daily deaths and the centesimal ratios, allowance was made for the fact that 1904 had 366 days.

The figures in the foregoing table indicate a departure in excess of the mean death-rate in the first four months of the year and in August and September, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of March, 1904, was 12 per cent. and those of January and April, 1904, were both 8.5 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1904, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mortality, since serious epidemics have not prevailed in the State either in the

past year or in any of the years of the past decade. The death-rate of 1904, like those of 1903, 1902 and 1901, was remarkably low.

Death-rates of Cities and Large Towns. — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the estimated population. They vary from a minimum of 8.5 in Bridgewater to 21.5 per 1,000 in Blackstone.

The following cities and towns had death-rates above 19 per 1,000 in 1904: Blackstone, 21.5; Stoneham, 20.0; New Bedford, 19.6; and Newburyport, 19.3.

Of the foregoing, Blackstone and New Bedford also had death-rates above 19 per 1,000 in 1903.

The following cities and towns had death-rates less than 12 per 1,000 in 1904: Williamstown, 11.7; Fitchburg, 11.6; Everett, 11.5+; Norwood, 11.4; North Attleborough, 11.4; Leominster, 11.3; Revere, 11.2; Clinton, 11.1; Whitman, 10.9+; Medford, 10.5; Newton, 10.4; Brookline, 10.2; Danvers, 10.2; Concord, 8.9+; Wellesley, 8.9; Winthrop, 8.7; Bridgewater, 8.5; of these, Bridgewater, Everett, Newton, Revere, Wellesley, Whitman, Williamstown and Winthrop also had death-rates below 12 per 1,000 in 1903.

The following table presents the mean death-rates of cities of over 25,000 population for the five census years 1870, 1875, 1880, 1885 and 1890, together with the death-rates for the years 1900 and 1904.

In all of these cities except two (Gloucester and Malden) there appears to have been decided improvement.

Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Five Census Years 1870, 1875, 1880, 1885, 1890, and for 1900 and 1904.

	Mean Death-rates, 1870, 1875, 1880, 1885 and 1890.	Death-rate, 1900.	Death-rate, 1904.		Mean Death-rates, 1870, 1875, 1880, 1885 and 1890.	Death-rate, 1900.	Death-rate, 1904.
Boston, . .	24.1	20.8	17.4*	Haverhill, .	17.8	15.2	13.8
Worcester, .	19.7	18.8	14.6*	Salem, . .	22.1	19.6	18.8
Fall River, .	23.4	21.0	17.2	Chelsea, . .	19.7	19.1	17.2*
Lowell, . .	22.5	19.5	16.6	Malden, . .	17.0	14.6	16.6
Cambridge, .	19.9	16.8	14.3	Newton, . .	18.1	14.9	10.4
Lynn, . .	17.8	15.8	14.9	Fitchburg, .	17.0	14.9	11.6
Lawrence, .	26.5	20.0	15.8	Taunton, .	19.5	21.1	18.1*
New Bedford, .	20.9	20.6	19.6	Gloucester, .	21.8	14.6	16.2
Springfield, .	19.3	18.4	16.0	North Adams,	17.7†	14.2	12.8
Somerville, .	18.2	15.7	13.7	Quincy, . .	18.7	14.4	13.0
Holyoke, . .	23.1	21.5	16.3	Waltham, .	15.3	15.6	12.8
Brockton, .	16.2	13.8	12.2				

* NOTE. — These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of non-residents in Boston and deaths in public and private institutions in the other three cities, the death-rates would be reduced to 16.4 in Chelsea, 15.9 in Boston, 14.4 in Taunton and 13.3 in Worcester.

† North Adams, for 1880, 1885 and 1890 only.

Causes of Death.

In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified according to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the estimated population of the group for 1904, as well as for each of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 154.65 per 10,000 living, or, as usually stated, 15.47 per 1,000, was lower than that of any of the preceding years; and, since the population comprised in these returns constitutes over 85 per cent. of that of the whole State, there are indications that the death-rate of the State was less than that of any year in the past century.

As in 1903, the decline in the general death-rate is chiefly due to a decrease in the relative number of deaths from infectious diseases, and especially from those which are usually considered preventable.

The death-rates from each of the following causes was less than that of 1903: smallpox, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, cerebro-spinal meningitis, puerperal fever, influenza, malarial fever, cholera infantum, pneumonia, bronchitis and diseases of the kidneys. Those of measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, cerebro-spinal meningitis, puerperal fever, malarial fever, cholera infantum, pneumonia and bronchitis were also less than the death-rates from the same causes in any of the last five years.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infectious diseases, and also shows that this combined death-rate in 1904 was less than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the ten years (1895–1904) in the cities and towns included in this report (about five-sixths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infectious Diseases.

Year.	Combined Death-rate per 10,000.	Year.	Combined Death-rate per 10,000.
1895,	46.4	1900,	40.7
1896,	46.8	1901,	33.5
1897,	39.7	1902,	30.9
1898,	36.3	1903,	30.7
1899,	35.2	1904,	27.0

The death-rate from consumption, while less than in 1902, was higher than during 1903, being 16.05 in 1904, 15.66 in 1903 and 16.38 in 1902.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 390.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past ten years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19.0, 19.0 and 17.5 in the ten succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43.0 and 45.7 per cent. in the same year.

These all combined constituted the greater part of the total mortality in each of the eleven years 1894–1904, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

TABLE I.

Population of Cities and Large Towns estimated for 1904.

Reporting Cities and Towns.	Estimated Population for 1904.	Reporting Cities and Towns.	Estimated Population for 1904.
Adams,	14,745	Arlington,	10,275
Amesbury,	9,473	Athol,	7,061
Amherst,	5,224	Attleborough,	14,561
Andover,	7,349	BEVERLY,	15,807

TABLE I. — Concluded.

Reporting Cities and Towns.	Estimated Population for 1904.	Reporting Cities and Towns.	Estimated Population for 1904.
Blackstone,	5,721	NEWBURYPORT,	14,419
BOSTON,	617,950	NEWTON,	39,310
Braintree,	6,517	NORTH ADAMS,	29,201
Bridgewater,	6,702	NORTHAMPTON,	20,314
BROCKTON,	46,601	North Attleborough,	7,798
Brookline,	23,576	Northbridge,	8,436
CAMBRIDGE,	100,998	Norwood,	6,204
CHELSEA,	36,496	Orange,	5,648
CHICOPEE,	21,692	Palmer,	8,557
Clinton,	15,694	Peabody,	12,406
Concord,	6,032	PITTSFIELD,	22,870
Danvers,	8,830	Plymouth,	11,139
Dedham,	7,653	QUINCY,	26,798
Easthampton,	6,255	Reading,	5,169
Easton,	5,168	Revere,	13,609
EVERETT,	30,209	Rockland,	5,327
FALL RIVER,	119,349	SALEM,	37,188
FITCHBURG,	36,335	Saugus,	5,552
Framingham,	12,974	SOMERVILLE,	70,413
Franklin,	5,017	Southbridge,	11,716
Gardner,	12,324	Spencer,	7,639
GLOUCESTER,	26,121	SPRINGFIELD,	72,020
Great Barrington,	6,702	Stoneham,	6,197
Greenfield,	9,283	Stoughton,	5,578
HAVERHILL,	39,061	TAUNTON,	34,577
Hingham,	5,251	Wakefield,	10,078
HOLYOKE,	50,538	WALTHAM,	25,797
Hudson,	5,570	Ware,	8,751
Hyde Park,	14,500	Watertown,	11,575
LAWRENCE,	72,348	Webster,	9,608
Leominster,	15,711	Wellesley,	5,748
LOWELL,	104,402	Westborough,	5,532
LYNN,	73,875	Westfield,	13,809
MALDEN,	37,205	West Springfield,	7,889
Marblehead,	7,582	Weymouth,	11,350
MARLBOROUGH,	13,609	Whitman,	6,483
MEDFORD,	21,956	Williamstown,	5,118
MELROSE,	13,819	Winchendon,	5,409
Methuen,	8,968	Winchester,	8,128
Middleborough,	7,041	Winthrop,	7,550
Milford,	13,771	WOBURN,	14,315
Milton,	7,426	WORCESTER,	136,925
Montague,	6,224		
Natick,	10,028	Total,	2,638,585
NEW BEDFORD,	68,863		

The death-rate of Amesbury, Athol, Blackstone, Franklin, Gloucester, Marblehead, Marlborough, Newburyport, Rockland and Stoneham was based on the population of 1900, these towns having slightly decreased in population in the five years which elapsed between the census of 1895 and 1900.

TABLE II.

Total Deaths, Deaths by Sexes and Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each with General Death-rates estimated for 1904.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Adams,	199	92	107	-	17	72	14	5	1	-	8	1	5	11	14	15	18	15	9	11	-	13.50
Amesbury,	160	75	85	-	9	33	2	-	-	1	2	1	5	6	11	20	16	19	21	23	-	16.89
Amherst,	81	41	40	-	-	15	-	-	-	-	-	1	2	1	5	4	7	9	20	17	-	15.51
Andover,	100	49	51	-	1	10	7	1	-	-	2	2	2	5	9	8	12	18	17	7	-	13.61
Arlington,	134	63	70	1	12	20	1	-	1	1	3	-	5	5	19	10	18	20	20	11	-	13.04
Athol,	111	62	49	-	10	16	2	2	2	1	-	1	2	4	10	6	11	10	27	17	-	15.72
Attleborough,	178	82	96	-	7	44	6	4	2	1	2	1	7	8	6	22	21	14	24	16	-	12.22
BEVERLY,	226	112	114	-	15	24	2	3	1	3	2	5	3	14	14	17	32	36	44	26	-	14.30
Blackstone,	123	64	59	-	11	22	5	2	1	-	6	1	1	8	14	13	12	17	14	7	-	21.50
BOSTON,*	10,757	5,568	5,189	-	663	2,207	455	217	126	100	244	141	222	901	1,197	1,119	1,217	1,182	916	513	-	15.85†
Braintree,	104	59	45	-	12	22	4	2	3	1	2	-	3	7	3	8	11	13	18	7	-	15.96
Bridgewater,‡	57	23	34	-	3	10	1	-	-	-	-	-	2	5	-	4	7	9	12	7	-	8.50
BROCKTON,	567	282	285	-	48	100	25	10	10	3	7	5	12	45	48	47	65	75	74	41	-	12.17
Brookline,	241	109	132	-	14	21	5	3	-	-	1	3	4	17	21	22	26	47	40	31	-	10.22
CAMBRIDGE,	1,444	709	735	-	91	206	58	22	15	17	22	18	44	115	146	119	139	187	143	108	-	14.30
CHELSEA,§	678	389	289	-	37	123	26	11	10	6	18	4	17	51	54	34	78	120	83	43	-	16.36†
CHICOPEE,	338	178	160	-	31	111	17	1	7	5	12	6	7	26	23	19	36	32	26	10	-	15.58
Clinton,	174	91	83	-	15	35	10	-	2	1	2	2	5	16	17	19	19	25	15	6	-	11.09
Concord,	54	26	28	-	8	10	1	1	-	1	3	-	3	9	5	2	3	5	8	3	-	8.95
Danvers,‖	90	36	54	-	4	9	1	1	-	-	3	-	4	4	6	7	9	10	17	19	-	10.19
Dedham,	128	70	58	-	10	19	1	-	-	1	2	1	2	12	6	7	15	18	23	21	-	16.78
Easthampton,	79	39	40	-	9	13	2	-	1	-	4	-	3	7	2	9	13	8	15	2	-	12.63
Easton,	76	45	31	-	3	9	1	1	1	-	2	3	-	5	2	5	12	15	15	5	-	14.71

EVERETT,	849	163	187	-	29	79	11	7	2	4	2	12	8	25	28	27	46	40	48	15	-	11.55
FALL RIVER,	2,047	986	1,061	-	150	812	72	71	69	86	61	52	36	144	137	120	145	125	72	45	-	17.15
FITCHBURG,	422	197	225	-	32	107	10	7	2	1	6	10	15	36	32	29	44	41	46	36	-	11.61
Framingham,	172	88	84	-	11	22	4	-	2	2	4	4	7	15	16	17	24	20	15	20	-	13.26
Franklin,	76	32	44	-	4	10	-	1	-	-	-	3	1	5	6	10	9	9	12	10	-	15.15
Gardner,	180	105	75	-	19	60	8	4	1	1	3	5	3	12	12	10	18	16	18	19	-	14.61
GLOUCESTER,	424	218	206	-	48	67	16	10	9	1	12	10	12	36	33	38	81	56	55	38	-	16.23
Great Barrington,	82	42	40	-	3	11	5	-	1	-	1	-	4	4	3	8	9	11	16	9	-	12.24
Greenfield,	144	69	75	-	6	20	8	-	3	1	6	1	3	12	12	9	11	12	24	21	1	15.51
HAVERHILL,	540	267	273	-	53	89	20	5	6	4	9	17	9	40	46	51	58	75	74	37	-	13.82
Hingham,	71	32	39	-	3	4	1	-	-	-	-	1	2	1	4	4	8	12	21	18	-	13.52
HOLYOKE,	826	398	428	-	66	273	81	12	7	9	21	12	18	68	61	74	81	78	67	14	-	16.34
Hudson,	76	40	36	-	11	11	-	-	-	-	5	1	2	5	7	10	8	8	12	7	-	13.64
Hyde Park,	208	100	108	5	18	46	9	6	2	1	7	3	1	13	14	18	30	29	21	7	1	14.35
LAWRENCE,	1,141	575	566	-	116	308	63	17	15	13	17	15	30	88	83	97	115	132	94	52	2	15.77
Leominster,	178	70	108	-	8	27	9	3	-	-	2	2	5	11	20	11	17	24	21	26	-	11.33
LOWELL,	1,736	860	876	-	43	498	92	41	24	18	34	25	40	124	184	127	170	192	143	74	-	16.63
LYNN,	1,104	547	557	-	95	213	23	16	8	13	23	15	32	92	108	99	100	152	144	70	1	14.94
MALDEN,	488	235	253	-	33	90	20	9	6	3	10	7	15	34	37	40	46	60	71	40	-	13.12
Marblehead,	139	72	67	-	3	10	3	5	1	2	4	1	4	7	7	7	17	22	27	22	-	18.33
MARLBOROUGH,	180	88	92	-	9	27	8	3	2	1	5	4	4	8	15	13	19	26	26	18	1	13.23
MEDFORD,	230	103	127	-	23	42	6	4	2	2	3	4	10	8	11	21	29	32	34	22	-	10.48
MELROSE,	199	99	100	-	13	29	8	1	3	-	3	2	6	13	17	12	24	24	31	26	-	14.40
Methuen,	121	71	50	-	15	25	2	1	2	1	5	-	4	6	18	14	5	16	15	7	-	13.49
Middleborough,	132	71	61	-	2	18	3	2	-	-	1	-	1	4	8	11	19	17	27	21	-	18.75
Milford,	172	87	85	-	18	17	8	3	2	2	4	1	2	13	25	22	14	26	18	15	-	12.49
Milton,	102	47	55	-	8	6	5	3	3	-	1	5	6	6	7	8	13	7	13	19	-	13.74
Montague,	118	65	53	-	10	16	2	5	-	-	1	2	4	10	12	13	9	21	13	7	3	18.96
Natick,	125	70	55	-	7	8	1	1	-	-	3	1	2	9	11	14	18	31	14	12	-	12.47
NEW BEDFORD,	1,347	711	636	-	124	423	60	28	11	13	16	11	33	115	98	97	118	135	114	80	-	19.56
NEWBURYPORT,	278	119	159	-	19	26	10	4	4	1	4	3	4	26	16	18	20	56	41	45	-	19.28

* Non-residents, 963 included. † In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
‡ State Farm, deaths at, not included. § Soldiers' Home, 81 included. || Insane Asylum, 194 not included.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
NEWTON,	410	194	216	-	18	54	15	5	6	4	8	7	17	24	40	26	35	60	67	42	-	10.43
NORTH ADAMS,	374	198	176	-	29	88	15	7	4	4	22	3	9	37	26	31	34	39	30	27	-	13.81
NORTHAMPTON,*	345	180	165	-	10	70	14	4	1	-	5	3	9	25	20	17	41	54	53	29	-	18.88†
North Attleborough,	89	42	47	-	9	18	2	1	-	-	4	-	3	5	7	6	9	18	13	3	-	11.41
Northbridge,	119	59	60	-	8	32	5	1	-	3	-	1	4	18	7	5	9	9	15	10	-	14.11
Norwood,	71	39	32	-	9	15	4	2	2	-	2	2	1	2	6	4	5	12	9	5	-	11.44
Orange,	80	45	35	-	6	7	3	-	1	-	2	1	2	4	9	3	8	5	14	21	-	14.16
Palmer,	134	70	64	-	9	47	8	8	-	3	2	-	3	10	4	10	5	16	12	6	-	15.66
Peabody,	172	88	84	-	14	35	3	-	-	3	3	1	6	10	15	12	23	21	20	20	-	13.86
PITTSFIELD,	405	199	206	-	17	54	10	7	2	4	14	1	14	41	36	34	32	50	65	40	1	17.71
Plymouth,	195	109	86	-	5	28	9	2	2	1	3	2	5	15	11	15	21	19	41	20	1	17.51
QUINCY,	347	166	181	-	23	75	19	6	5	4	14	4	13	30	23	28	28	35	40	23	-	12.95
Reading,	75	42	33	-	6	6	2	-	2	2	1	1	-	6	5	5	1	11	16	17	-	14.51
Revere,	153	73	80	-	16	35	6	1	4	2	3	1	2	14	9	16	14	22	17	7	-	11.24
Rockland,	80	37	43	-	3	7	2	-	1	2	1	-	-	5	9	7	10	11	15	10	-	15.02
SALEM,	698	337	361	-	44	166	20	6	7	5	10	11	17	52	52	62	69	88	79	54	-	18.77
Saugus,	92	47	45	-	6	16	4	1	2	1	1	-	3	6	5	6	9	11	19	8	-	16.57
SOMERVILLE,	964	492	472	-	68	169	33	12	15	9	22	17	20	60	69	89	97	133	144	75	-	13.69
Southbridge,	196	106	90	-	7	58	13	11	11	3	11	3	6	10	12	13	5	13	15	11	1	16.73
Spencer,	97	51	46	-	6	15	-	1	1	-	2	1	2	7	11	8	11	15	12	11	-	12.70
SPRINGFIELD,	1,149	549	600	-	72	207	28	12	14	8	27	22	28	97	105	93	115	156	146	91	-	15.95
Stoneham,	124	61	63	-	6	12	1	3	1	1	-	-	-	9	11	13	15	16	24	18	-	20.01
Stoughton,	106	54	52	-	4	15	3	2	-	1	2	2	2	10	10	13	9	9	14	14	-	19.00
TAUNTON,‡	624	316	308	-	38	122	18	10	10	4	11	4	10	42	50	52	61	89	93	47	1	14.40†
Wakefield,	133	67	66	-	11	20	3	1	-	-	3	-	2	8	10	10	15	16	29	16	-	13.20

WALTHAM, ...	330	153	177	-	14	43	4	3	2	4	11	6	10	32	29	27	30	46	54	29	-	12.79
Ware, ...	126	62	64	-	7	35	3	-	2	-	2	-	1	14	13	6	10	8	15	17	-	14.40
Watertown, ...	154	77	77	-	23	25	5	3	1	3	2	1	1	8	19	12	18	17	20	18	1	13.30
Webster, ...	160	95	65	-	12	43	10	2	-	-	1	1	4	14	18	8	14	19	20	11	-	16.65
Wellesley, ...	51	24	27	-	3	6	2	-	1	-	1	-	2	6	7	1	7	8	7	7	1	8.87
Westborough,§ . . .	183	89	94	-	2	6	1	-	1	-	1	1	1	11	17	21	37	36	38	12	-	12.65†
Westfield, ...	204	110	94	-	17	40	-	3	2	2	3	2	5	16	11	16	29	19	30	26	-	14.77
West Springfield, . .	112	61	51	-	4	26	3	-	2	1	3	4	2	13	4	8	7	20	14	5	-	14.20
Weymouth, ...	176	80	96	-	12	16	4	5	-	3	4	2	5	10	16	12	16	22	39	22	-	15.51
Whitman, ...	71	39	32	-	2	11	1	-	-	2	2	-	1	6	2	5	11	11	12	7	-	10.95
Williamstown, . . .	60	23	37	-	3	12	1	1	-	1	1	-	2	1	3	2	12	6	9	9	-	11.73
Winchendon, . . .	81	38	43	-	6	11	6	-	2	-	2	1	3	4	6	6	11	12	10	7	-	14.98
Winchester, ...	106	47	59	-	9	17	3	-	-	-	4	-	4	4	9	9	12	13	13	18	-	13.04
Winthrop, ...	66	31	35	-	7	10	-	1	-	-	4	-	1	7	4	9	4	13	11	2	-	8.74
WOBURN, ...	195	102	93	-	9	41	10	4	4	1	-	2	5	9	11	12	21	35	24	16	-	13.62
WORCESTER,‖ . . .	1,993	1,051	942	-	123	364	66	25	15	11	53	27	46	161	179	183	220	255	238	150	-	13.26†
Totals, ...	40,806	20,598	20,207	6	2,716	8,707	1,523	705	493	418	887	559	954	3,135	3,565	3,500	4,207	4,870	4,494	2,779	15	15.47

* Insane Hospital, 63 included. † In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
‡ Insane Asylum, 126 included. § Insane Asylum, 113 included. ‖ Insane Asylum and Insane Hospital, 178 included.

TABLE III.

Deaths from Specified Causes in Cities and Towns having More than 5,000 Inhabitants in Each.

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Adams,	14	1	-	-	5	2	3	2	-	1	2	-	17	-	-	20	2	5	4	6	4	8	-	-	107
Amesbury,	16	-	-	-	-	2	4	-	1	-	1	-	6	2	2	25	1	33	15	11	12	-	3	-	26
Amherst,	5	-	-	-	-	-	-	1	-	-	-	-	5	1	1	4	2	6	8	5	7	-	1	-	40
Andover,	7	-	-	-	2	-	1	3	-	-	-	-	-	-	-	15	-	20	7	1	12	-	6	-	25
Arlington,	6	-	-	1	2	-	-	5	1	-	-	-	4	1	-	8	3	15	-	1	5	2	4	-	76
Athol,	7	-	-	-	2	-	-	3	1	-	-	-	4	-	-	7	1	15	25	11	2	1	2	2	28
Attleborough,	20	-	-	-	3	-	1	-	-	-	2	-	11	1	-	7	5	16	20	13	10	-	14	-	55
BEVERLY,	26	-	-	-	1	1	3	4	1	-	-	1	4	-	1	23	4	40	29	15	13	1	6	-	52
Blackstone,	6	-	-	-	1	-	1	2	-	-	-	-	3	4	1	21	6	9	3	4	-	2	8	-	52
BOSTON,	1,269	-	89	39	206	29	135	37	62	18	65	2	206	20	422	1,823	278	1,056	648	543	565	80	451	90	3,108
Braintree,	9	-	1	3	1	1	2	1	1	-	1	3	5	-	1	8	4	11	16	5	4	-	5	-	21
Bridgewater,	4	-	-	-	-	-	1	1	1	-	-	-	2	-	1	5	4	9	5	4	2	-	-	11	7
BROCKTON,	74	-	12	1	3	-	8	17	-	6	6	1	13	6	4	39	14	69	46	25	30	5	10	2	176
Brookline,	13	-	-	1	1	-	1	3	3	-	2	-	3	-	1	25	7	47	18	13	23	2	2	-	74
CAMBRIDGE,	190	-	8	3	25	3	23	6	5	-	9	-	28	3	81	146	35	193	152	66	82	8	52	68	257
CHELSEA,	59	-	3	2	13	-	11	6	-	-	10	-	18	-	7	46	13	78	50	37	27	6	10	-	281
CHICOPEE,	30	-	1	3	7	1	2	1	2	-	3	-	25	-	-	21	16	27	59	20	13	1	7	2	97
Clinton,	6	-	-	-	-	-	3	-	1	-	-	-	4	2	7	26	7	20	-	8	3	3	7	-	77
Concord,	8	-	-	-	-	-	-	2	1	-	2	-	-	-	-	4	1	3	8	2	4	1	2	-	16
Danvers,	10	-	-	-	-	-	1	4	-	-	-	-	-	-	-	14	1	11	2	3	8	1	-	-	35
Dedham,	12	-	1	-	-	-	-	1	1	-	-	3	2	1	-	9	3	22	26	7	3	-	8	1	33
Easthampton,	12	-	-	-	1	-	-	4	-	2	-	2	4	2	1	4	-	4	7	4	1	1	4	-	26
Easton,	8	-	-	-	-	-	-	-	-	-	1	1	1	-	-	9	1	9	2	12	4	1	2	1	24

EVERETT, . . .	45	-	-	1	7	-	2	2	-	-	4	-	8	2	1	42	7	43	1	3	13	3	8	-	157
FALL RIVER, . .	158	-	6	2	45	20	19	3	5	2	2	1	218	13	31	133	156	97	298	67	33	2	59	15	662
FITCHBURG, . .	35	1	-	-	1	3	3	-	1	-	1	1	15	1	-	41	12	52	3	8	25	3	22	15	179
Framingham, . .	15	-	-	1	-	-	2	2	-	1	1	-	-	-	-	12	1	10	3	1	5	2	13	-	98
Franklin, . . .	4	-	-	-	-	-	1	1	1	-	-	-	-	-	-	11	3	4	9	3	4	1	4	-	29
Gardner, . . .	25	-	-	-	6	2	4	10	2	-	5	-	5	-	-	18	8	12	11	8	1	1	4	-	63
GLOUCESTER, . .	7	-	-	3	6	-	2	3	-	1	-	-	6	1	-	23	4	27	1	19	13	7	12	-	289
Great Barrington, .	3	-	-	-	1	-	-	-	-	-	-	-	4	4	-	5	3	9	11	9	7	-	3	-	23
Greenfield, . . .	14	-	-	2	2	-	1	4	-	-	-	-	4	1	1	17	1	16	8	9	4	3	8	-	49
HAVERHILL, . .	64	-	7	-	2	-	5	1	1	-	4	1	-	1	17	58	9	74	68	28	33	10	25	3	138
Hingham, . . .	6	-	-	-	-	-	1	-	-	-	-	-	-	1	2	7	2	10	11	2	4	-	2	4	19
HOLYOKE, . . .	106	-	-	2	15	7	4	1	2	-	8	-	56	2	50	85	19	83	91	56	37	8	20	-	174
Hudson, . . .	12	-	-	-	-	-	2	-	-	-	1	-	3	1	-	3	1	14	7	4	6	-	3	-	19
Hyde Park, . .	29	-	-	1	-	2	-	-	1	1	-	-	7	-	3	29	4	15	8	9	6	4	10	-	79
LAWRENCE, . .	120	-	1	3	7	6	11	2	2	-	5	-	82	6	7	140	36	89	92	80	88	10	17	19	368
Leominster, . .	22	-	-	1	-	-	1	5	-	-	-	-	6	3	-	11	4	30	8	18	6	1	5	-	62
LOWELL, . . .	143	1	14	5	34	2	17	5	2	2	5	-	113	5	125	175	72	182	203	85	65	10	52	11	458
LYNN, . . .	186	-	-	-	21	1	17	6	1	-	-	-	24	1	9	104	20	117	91	78	64	10	32	9	366
MALDEN, . . .	50	-	2	1	5	-	7	1	4	-	2	-	18	3	1	66	10	74	54	19	23	1	1	1	145
Marblehead, . .	13	-	-	-	5	-	-	2	-	-	1	-	1	1	-	6	1	21	13	7	7	2	3	-	56
MARLBOROUGH, .	12	-	-	1	3	-	2	15	1	1	-	-	2	-	1	12	1	17	-	6	8	-	4	-	94
MEDFORD, . . .	16	-	-	1	2	-	2	-	-	-	-	1	12	-	-	26	4	20	2	4	18	1	1	-	120
MELROSE, . . .	20	-	-	-	2	4	1	-	-	-	2	-	1	-	-	18	10	24	20	11	17	2	11	9	47
Methuen, . . .	11	-	-	3	2	-	2	8	2	4	2	-	6	3	2	15	5	20	9	7	5	2	3	-	9
Middleborough, .	11	-	-	-	1	-	2	2	-	-	-	-	3	-	-	6	3	22	6	-	9	1	7	-	59
Milford, . . .	15	-	-	-	1	-	-	-	3	-	1	1	1	3	-	19	3	14	14	25	8	1	9	-	49
Milton, . . .	9	-	-	-	1	-	1	-	-	-	-	-	-	-	-	13	1	9	1	4	4	2	3	-	54
Montague, . . .	4	-	-	-	1	-	2	6	-	-	-	1	5	-	-	16	4	5	-	3	-	-	8	-	63
Natick, . . .	18	-	-	-	1	-	1	1	-	-	-	-	1	-	-	10	-	30	5	9	9	1	6	-	33
NEW BEDFORD, .	137	-	-	-	10	1	12	4	6	-	7	-	96	2	3	144	35	128	105	80	48	3	5	-	521
NEWBURYPORT, .	15	-	-	-	3	2	3	2	1	1	1	-	7	-	1	11	8	16	14	16	25	3	13	3	132

TABLE III. — *Concluded.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
NEWTON, ...	33	–	1	1	6	–	4	2	–	1	4	–	–	3	1	38	7	42	50	22	22	–	12	–	161
NORTH ADAMS, .	32	5	–	4	19	1	10	–	2	–	2	–	–	1	3	41	–	20	34	12	8	2	21	1	156
NORTHAMPTON, .	29	–	3	–	–	1	3	–	1	–	1	1	17	5	8	27	6	45	54	16	15	3	10	11	89
North Attleborough, .	12	–	–	–	–	–	1	–	–	–	1	2	2	–	1	9	2	6	17	6	6	2	–	–	23
Northbridge, . .	16	–	–	–	1	1	1	5	1	–	–	1	5	1	4	16	3	14	1	10	6	–	5	5	23
Norwood, . . .	2	–	–	–	3	–	–	3	–	1	–	–	3	2	–	4	4	15	7	5	–	–	–	–	22
Orange, . . .	8	–	–	–	1	–	–	6	1	–	–	–	1	–	–	4	2	9	14	8	1	2	2	1	20
Palmer, . . .	19	–	–	–	3	2	1	–	1	1	3	–	8	1	8	19	–	19	12	4	7	–	4	2	20
Peabody, . . .	13	–	–	–	2	–	1	4	–	–	–	–	7	6	2	15	7	37	14	9	10	–	4	–	41
PITTSFIELD, . .	45	–	–	–	6	–	8	12	3	6	–	–	14	5	3	46	10	72	14	24	23	–	22	47	42
Plymouth, . . .	12	–	1	–	2	–	6	6	–	1	–	–	6	–	7	11	10	29	27	13	15	–	17	–	32
QUINCY, . . .	40	–	5	1	9	1	1	–	1	–	2	–	23	–	–	39	9	55	32	11	18	4	19	–	77
Reading, . . .	12	–	–	1	1	–	–	2	–	–	–	–	1	1	–	6	1	1	7	2	5	–	3	–	32
Revere, . . .	18	–	–	–	2	1	2	5	–	–	1	1	7	1	1	15	6	23	11	8	9	–	7	–	35
Rockland, . . .	10	–	–	–	2	–	–	1	–	–	–	–	1	2	–	7	–	10	9	11	3	1	3	7	13
SALEM, . . .	56	–	–	–	11	2	8	1	–	–	3	–	46	2	9	44	25	87	28	34	43	6	16	–	277
Saugus, . . .	13	–	2	–	2	–	–	2	1	–	–	–	2	–	3	8	4	12	4	4	1	1	6	–	27
SOMERVILLE, . .	94	–	3	3	14	–	11	19	5	–	6	–	13	4	6	110	30	103	70	76	52	1	34	–	310
Southbridge, . .	19	–	–	–	18	2	–	–	–	–	–	–	4	1	7	6	4	11	1	9	4	1	3	35	71
Spencer, . . .	15	–	–	–	2	–	–	3	–	–	–	–	4	1	1	11	–	7	5	6	6	–	2	14	20
SPRINGFIELD, . .	108	–	3	12	26	4	11	3	6	7	6	–	18	2	38	79	9	141	14	114	69	7	49	24	392
Stoneham, . . .	14	–	–	–	3	–	1	–	–	1	1	–	–	–	–	13	3	20	16	10	8	–	2	–	32
Stoughton, . . .	12	–	–	–	1	–	3	–	–	–	1	–	1	–	–	10	–	11	8	7	6	–	3	–	43
TAUNTON, . . .	63	–	–	3	5	–	1	–	4	1	5	3	12	3	36	36	19	41	3	32	15	1	1	–	290
Wakefield, . . .	19	–	–	–	–	–	–	7	–	–	–	–	–	–	–	14	5	18	16	8	6	–	4	–	36
WALTHAM, . . .	45	–	–	–	4	–	4	1	1	–	5	–	4	3	7	39	11	49	36	15	19	–	–	4	83

Ware, ...	12	-	-	-	-	-	-	-	-	-	-	-	9	-	1	14	-	7	5	-	6	-	2	-	70
Watertown, . .	21	-	-	-	2	1	1	6	-	3	1	-	5	2	-	17	7	16	16	9	5	3	7	12	19
Webster, . . .	21	-	-	-	2	1	1	2	2	-	-	-	6	3	-	18	1	8	2	2	4	2	1	-	84
Wellesley, . . .	8	-	-	1	1	-	-	3	-	-	-	-	-	-	-	5	2	5	5	2	1	1	1	-	16
Westborough, . .	16	-	-	-	-	-	-	2	-	-	-	1	1	-	-	3	1	16	99	15	7	-	3	-	19
Westfield, . . .	21	-	-	-	6	-	4	2	-	-	-	-	3	1	-	14	2	34	10	8	8	-	11	-	80
West Springfield, .	11	-	-	1	2	-	-	4	1	-	-	-	5	-	1	11	2	10	-	14	1	-	4	-	45
Weymouth, . .	21	-	1	1	3	-	1	6	-	-	2	-	4	-	-	20	3	27	18	14	7	2	6	10	80
Whitman, . . .	5	-	-	-	2	-	-	-	-	1	-	-	1	4	2	9	1	8	13	3	3	-	2	1	16
Williamstown, . .	7	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	4	7	4	1	2	-	3	-	28
Winchendon, . .	11	-	-	-	-	-	3	1	-	1	-	-	1	-	-	14	2	11	12	2	4	-	2	-	17
Winchester, . .	4	-	-	-	1	1	-	-	-	-	3	-	1	-	2	8	4	15	10	3	7	3	2	-	42
Winthrop, . . .	3	-	-	-	-	-	1	-	-	-	-	-	-	1	2	6	2	10	8	10	6	2	5	5	5
WOBURN, . . .	17	-	-	-	1	-	-	-	-	-	-	-	8	1	-	19	2	9	11	7	9	2	4	-	105
WORCESTER, . .	211	-	1	5	8	12	5	-	8	6	-	2	60	8	10	229	57	244	291	120	112	15	83	3	498
Totals, . . .	4,234	8	165	113	628	119	420	297	154	70	203	30	1,374	166	947	4,181	1,117	4,276	3,315	2,175	1,938	273	1,357	448	12,742

Homicide.

Adams, ...	1
Andover, ...	1
BEVERLY, ...	1
BOSTON, ...	24
Brookline, ...	2
Franklin, ...	1
HAVERHILL, ...	1
Methuen, ...	1
NEWBURYPORT, ...	1
SPRINGFIELD, ...	3
Watertown, ...	1
WORCESTER, ...	5
	42

Anthrax.

LYNN, ...	2

Actinomycosis.

BOSTON, ...	1

Glanders.

CHELSEA, ...	1

Malignant Pustule.

BOSTON, ...	1
CAMBRIDGE, ...	1
	2

Tetanus.

Braintree, ...	1
PITTSFIELD, ...	3
SPRINGFIELD, ...	2
	6

Trichinosis.

SPRINGFIELD, ...	2

TABLE IV.

Deaths from Specified Causes, 1904, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1900-1904), Deaths per 1,000 from All Causes, 1900-1904.

CAUSES OF DEATH.	Deaths. 1904.	MORTALITY PER 10,000 OF THE POPULATION.					DEATHS PER 1,000 FROM ALL CAUSES.				
		1904.	1903.	1902.	1901.	1900.	1904.	1903.	1902.	1901.	1900.
Consumption, . . .	4,234	16.05	15.66	16.38	17.63	18.56	103.76	97.06	101.06	104.58	101.60
Smallpox, . . .	8	0.03	0.08	1.12	0.39	0.008	0.20	0.51	6.89	2.30	0.046
Measles, ...	165	0.63	0.69	0.92	0.73	0.99	4.04	4.27	5.66	4.35	5.44
Scarlet fever, . . .	113	0.43	1.75	1.13	1.46	1.51	2.77	10.85	6.99	8.64	8.29
Diphtheria and croup, .	628	2.38	2.94	3.22	4.40	5.87	15.39	18.20	19.84	26.13	32.12
Whooping-cough, . .	119	0.45	1.64	0.96	0.84	1.27	2.92	10.19	5.96	4.99	6.85
Typhoid fever, . .	420	1.59	1.81	1.88	1.96	2.25	10.29	11.24	11.59	11.61	12.34
Cerebro-spinal meningitis.	297	1.13	1.33	1.39	1.46	1.63	7.28	8.23	8.60	8.69	8.91
Erysipelas, . . .	154	0.58	0.35	0.44	0.47	0.66	3.77	2.16	2.74	2.79	3.66
Puerperal fever, . .	70	0.27	0.33	0.32	0.34	0.37	1.72	2.04	1.98	2.00	2.01
Influenza, . . .	203	0.77	1.06	0.43	1.90	2.28	4.97	6.60	2.64	11.29	12.44
Malarial fever, . .	30	0.11	0.16	0.15	0.19	0.22	0.74	1.02	0.94	1.14	1.23
Cholera infantum, . .	1,374	5.21	5.89	6.05	6.11	9.87	33.67	36.50	37.36	36.28	54.10
Dysentery, . . .	166	0.63	0.62	0.70	0.72	0.75	4.07	3.88	4.35	4.25	4.12
Diarrhœa and cholera morbus.	947	3.59	3.29	3.71	3.54	3.84	23.21	20.36	22.88	20.99	21.00
Pneumonia, . . .	4,181	15.85	16.48	16.07	16.66	18.40	102.46	102.11	99.21	98.83	100.70
Bronchitis, . . .	1,117	4.23	4.55	4.69	4.47	5.09	27.37	28.17	28.96	26.50	27.68
Diseases of the heart, .	4,276	16.21	15.25	15.66	15.70	16.16	104.79	94.52	96.40	93.12	88.45
Diseases of the brain and spinal cord.	3,315	12.56	11.15	12.17	10.41	10.81	81.24	69.10	75.12	61.76	59.00
Diseases of the kidneys,	2,175	8.24	8.45	7.38	7.75	7.32	53.30	52.36	45.57	46.01	40.05
Cancer, ...	1,938	7.34	7.05	6.91	6.19	6.53	47.49	43.70	42.66	36.75	35.75
Suicide, ...	273	1.03	1.05	1.02	1.05	0.99	6.69	6.50	6.30	6.22	5.39
Accident, ...	1,357	5.14	5.43	5.40	5.39	5.20	33.25	33.66	33.31	31.95	28.50
Unknown or ill-defined causes.	448	1.70	1.91	1.64	1.77	2.63	10.98	11.84	10.11	10.52	14.38
All causes, . .	40,806	154.65	161.32	162.07	168.58	182.60	-	-	-	-	-

HEALTH OF TOWNS.

HEALTH OF TOWNS.

The following digest consists chiefly of extracts from the annual reports of the boards of health of cities and towns for the year 1904, illustrating the character and extent of the sanitary work performed by the local authorities.

One hundred cases of smallpox were reported for the year 1904, as against 417 for the year 1903 and 2,305 for the year 1902, showing a marked decrease in the prevalence of this disease.

There has been a decrease in the number of reported cases of scarlet fever for the year 1904, as compared with the number reported for 1903. The largest number of deaths from this disease occurred in Springfield (7 deaths in 129 cases), the fatality being 5.4 per cent. In Boston there were 966 reported cases and 39 deaths, a fatality of 4.0 per cent. In Cambridge, 135 cases with 3 deaths, the fatality being 2.2 per cent.; in Fall River, 102 cases with 2 deaths, the fatality being 1.9 per cent.; in Lowell the fatality was 4.2 per cent., in Somerville 2.5 per cent., in Worcester 2.1 per cent., while in Newton it was about 1 per cent.

Following the extracts from the reports of local boards of health will be found a table showing the visits and inspections made by the medical inspector of the State Board of Health, for the purpose of aiding local authorities in controlling the spread of smallpox.

The following numerical statement of bacteriological work performed by local boards of health is also taken from the annual reports of those boards for the year 1904: —

Bacteriological Work performed by Local Boards of Health and by the State Board of Health, 1904.

	Diphtheria Cultures.	Tuberculosis.	Typhoid Fever.	Malaria.	Packages of Antitoxin distributed.
Boston,*	9,237	3,115	1,164	134	-
Brockton,†	176	219	69	44	-
Brookline,	643	118	58	26	-
Cambridge,	1,438	267	275	-	-
Fall River,	289	-	147	-	-
Fitchburg,	63	93	46	-	-
Greenfield,	20	-	-	-	-
Holyoke,	378	-	-	-	-
Lowell,	1,389	257	181	7	-
Lynn,	937	-	-	-	-
New Bedford,	239	85	4	-	-
Newton,	66	-	75	-	-
Palmer,	37	-	-	-	-
Somerville,	1,429	124	76	-	-
Springfield,	1,431	19	-	-	-
Waltham,	228	27	-	-	-
Worcester,	1,328	422	-	-	-
State Board of Health,‡ §	1,014	494	204	24	22,255

* Glanders, 147; other diseases, 91.

† Other diseases, 56.

‡ Other diseases, 3.

§ Six months ending Sept. 30, 1904.

Amesbury.

After months of satisfactory conditions, a single case of scarlet fever was reported. About one week later 8 cases were reported in one day. So rapidly did it spread that in a few days the board found that they were grappling with the most extensive epidemic that had invaded the town for years. Upon investigation, it was found that nearly all of the first 30 cases followed in the track of one milk supply. It was thought best to ask the aid of the State Board of Health in determining the cause and the amount of quarantine regulations advisable. The State inspector was soon on the scene, and, acting in conjunction with the local board, visited not only this milk farm, but every case that had been reported at that date. It was learned that no scarlet fever had occurred at the farm for some years, and everything about the place was neat and clean. Further, it appeared that several cases of scarlet fever had occurred about town, of so mild a character as to be unrecognized. From these, and by that system of milk delivery practised within the past few years, of leaving individual receptacles which were supposed to be cared for by the householder, but which really received insufficient attention, the disease was transmitted broadcast. The owner of the milk route suffered a financial loss and injustice for that in which he was in no way responsible. The fault is in the system of distribution followed by him and others, which we heartily condemn, unless the producer is provided with, and will use, adequate means for sterilizing the bottles and cans.

The quarantine was not observed in all cases to the satisfaction of the board. They must perforce rely upon the attending physician to see that the details are enforced. Cases have come to our notice where members of the family have been allowed undue latitude, and even to resume work, before the process of disinfection had been complete. Every medical man should join his efforts with the board of health in the attempt to control this or any other of the dreaded diseases. Fortunately, the cases, numbering nearly 80, have been mild in character.

Beverly.

Such inspection of bakeries as is prescribed by law has been made. In a majority of cases these important places, where so much of our food product is manufactured, were found to be in a good general condition. Twelve bakeries are at present in operation in the city.

The steady growth of the city constantly increases the amount of garbage to be collected and gotten rid of. The collection of garbage the past year has been done by parties licensed by the board to collect in allotted sections of the city. The greater part of the amount collected has been disposed of outside of the city.

Boston.

The total number of deaths for the year was 10,757, an increase over the previous year of 125 deaths. The death-rate for the year, as calculated, is 17.50 per 1,000 inhabitants. This rate is less by .19 than that of the previous year, and the lowest on the city's record. There were 2,311 deaths from infectious diseases, including consumption, an increase of 19 deaths. There were 8 less deaths from diphtheria and croup than in 1903, but a large proportionate increase in the number of cases. The percentage of deaths to the number of cases of diphtheria reported was 8.12, as against 10.32 per cent. the preceding year. There were 39 deaths from scarlatina, 26 less deaths than in the preceding year, and 84 deaths less than the average for the five previous years. Typhoid fever caused 135 deaths during the year, 16 more deaths than the preceding year. The respiratory diseases caused fully 27 per cent. of the mortality for the past year.

Disinfection, 1904,— Materials used.

Formaldehyde,	1,860 gallons.
Alcohol (for heat),	785 gallons.
Chloride of lime,	49,000 pounds.
Bichloride of mercury,	875 pounds.
Chloride of sodium (in mixing),	1,050 pounds.

Medical Inspection of Schools.— Summary.

Specific infectious diseases,	516
Oral and respiratory diseases,	1,318
Diseases of the ear,	123
Diseases of the eye,	714
Diseases of the skin,	3,985
Miscellaneous diseases,	3,743
Found free from disease,	5,753
Total,	16,152

Number of pupils examined in the schools,	16,152
Number recommended to be sent home,	3,259
Number consultations with teachers (about pupils returning to school, etc.),	2,372

Contagious Diseases.—The reduction in the mortality from diphtheria since 1895 has been due principally to the extensive use of antitoxin and skilful intubation, both in hospital and in the homes. The average annual percentage of mortality to the total number of cases of diphtheria for ten years prior to the use of antitoxin in 1895 was 35.66 per cent. The percentage of mortality since 1895 has been 11.53 per cent. No case of smallpox was found in this city during the calendar year ending Dec. 31, 1904. If simple isolation and disinfection have been responsible for the greatly

diminished morbidity and mortality from scarlet fever in Boston since 1877, they have been more effective than in any other infectious disease in our city. Smallpox alone has been diminished as much, but in that disease we have the advantage of vaccination, which supersedes all other measures. The annual mortality from scarlet fever for ten years previous to 1877 averaged 317, and for the twenty-eight years since it has averaged 116. The average annual number of deaths from smallpox in Boston from 1840 to 1873 inclusive was 86.7, and from 1874 to 1904 inclusive 10.9.

Milk Inspection. — The condition of the milk sold in Boston has as a whole proved satisfactory, and the number of prosecutions was not materially larger than for the preceding year. During the summer months it was found that some of the cream upon the market was being preserved by the use of sodium benzoate. A large number of samples were collected, and subjected to analysis. This resulted in the conviction, with substantial fines, of four sellers of the cream, and the stopping of further use of this preservative. The employment of other preservatives and of coloring matters in milk has been reduced to a minimum. A number of contractors have issued circular letters to the farmers whose milk they purchase, explaining the necessity of proper methods of milking, cooling and storage; and it is their intention, in making new contracts, to provide that the milk sent to Boston shall have been produced under conditions approved by the board of health.

The total number of samples collected and examined was 18,846, as follows: —

Number of samples of milk from wagons,	6,812
Number of samples of milk from stores,	6,499
Number of samples of milk brought in by citizens,	169
Number of samples of milk (bacteriological),	3,300
Total milk samples,	16,780
Number of samples of vinegar,	603
Number of samples of butter, cheese and oleomargarine,	1,463
Total samples,	18,846

Stables. — Hearings were had on fifty-two applications for the occupation of stables, with the following result: —

Granted,	34
Refused,	10
Awaiting action,	5
Withdrawn,	3

Examination of Plumbers. — During the past year weekly examinations have been held by the board of examiners of plumbers. Of the number who applied for masters' licenses, 31 passed satisfactory examinations and

were granted licenses and 43 were refused, not having passed satisfactory examinations. Of those who applied for journeymen's licenses, 50 were granted and 74 refused.

Dumps. — The growth of the city, and with it the enormous increase of waste matter to be gathered up and so disposed of as to prevent its becoming a source of annoyance and sickness, call for greater care in its disposal. The board respectfully begs to refer again to its recommendation in its annual report of 1895 for the systematic burning of this waste material in several sections of the city, and at moderate cost, to abate one of the great sources of annoyance and complaint throughout the city.

Poultry. — In October the board passed the following regulation respecting the killing and keeping of poultry: —

Voted, That no live chickens, geese, turkeys, ducks or other fowls shall be brought into or kept or held or offered for sale or killed in any place in the city of Boston without a permit therefor in writing from the board of health, which permit shall be subject to revocation by said board at any time; and it is further

Ordered, That no carcass of poultry shall be plucked in said city except in such places as are now or may hereafter be assigned by said board for said purpose; and it is further

Ordered, That no carcass of unplucked poultry shall be brought into or exposed or offered for sale or sold in said city.

Bacteriological Laboratory. — Plans were made and approved in the early part of the year for the removal of the laboratory to a new location on Boylston Street, and on Aug. 29, 1904, the transfer took place. No interruption of the routine work was permitted, but special investigations were much hampered, and, in most instances, abandoned. The most satisfactory feature, from the executive standpoint and the standpoint of the physician, has been the introduction of a new device, original with the director of the laboratory, for the delivery of cultures directly into an incubator. This device is available to a messenger from the physician at any hour after the laboratory closes at 6 P.M. About one hundred cultures per month have arrived in this way, all of which would have been delayed about thirty-six hours under the old methods.

Special work in the line of new devices was as follows: porous tops for Petri dishes; method for preparing specimens for staining flagella; staining bath for Gram's method; a method of preparing dialysing membranes; a new form of water-pressure filter for toxins, mallein, etc.

This laboratory now acts as a depot for the distribution to physicians of vaccine and antitoxin made by the Massachusetts State Board of Health, and supplies mallein, made in this laboratory, to veterinarians.

Inspection of Animals. — The inspector of animals reports 76,777 animals slaughtered at the abattoir. One hundred and thirty-one animals, weighing in the aggregate 11,880 pounds, were condemned.

Twenty-eight cases of actinomycosis were found. Tuberculosis was found in 282 cattle and 2 swine.

The inspection of cattle kept for the production of milk within the city limits has been continued as heretofore. Five animals were found tuberculous, and quarantined. Six cases of actinomycosis were found in cows kept for the production of milk.

Suspicious cases of glanders among horses to the number of 292 have been reported to the board of health, of which 212 were found to be infected.

Six cases of suspected rabies have been reported to the board, one of which proved to be a case of rabies, which was brought to one of the veterinary hospitals in this city from Somerville.

Brockton.

In praise of the work of the bacteriological department, and of its importance, too much cannot be said. During the past year nearly 600 examinations have been made for the physicians of the city; for diphtheria, 115, of which only 28 were found positive, thus relieving many households (in some cases several in a house) from quarantine, which a clinical examination might have required, and which imposes a great and sometimes unnecessary hardship. We are pleased to state that this branch of our department is receiving the most hearty commendation, not only from the physicians of the city, but from many citizens who are acquainted with the work it is accomplishing.

Antitoxin has been supplied freely, and the confining of the disease to the one sick, in families where there were several children, we believe is due to immunizing with 500 unit injections the other members of the families, — a practice which the board insists shall be adopted by all physicians just as far as possible. We also believe the low death-rate is due in a measure to the free use of antitoxin as quickly as possible, whenever and wherever a clinical examination indicates diphtheria to be present.

Brookline.

There were 66 persons admitted to the hospitals for contagious diseases, 1 more than last year. The maintenance of the hospitals has cost considerably less than last year, largely because there were a good many exceptional expenditures last year before the hospitals were in thorough working order. There have been some further expenses of the same kind this year and some repairs; also one of the old wooden buildings has been extensively fitted up and improved.

Much has been done in the way of filling up or draining off unnecessary pools of standing water which were affording breeding places for mosquitoes, and water which could not be drained off has in many cases been petrolized,

particularly in the street catch-basins. A good many landowners are disposed to co-operate willingly, either doing the work themselves or paying the cost of it, but there are still some who have done little or nothing. There are fewer people than there were who believe that mosquitoes can be wholly exterminated in a single season, but there is an increasing number who think that much good will be accomplished by the work that is being done.

The need in this neighborhood of more adequate hospital accommodations for poor patients in the advanced and most infectious stage of consumption is still very great. It is practically impossible for a consumptive in the latter stages to live in a boarding-house or tenement without being a real menace to the health of those about him.

From Feb. 1, 1904, to Jan. 31, 1905, the disinfector for the board disinfected with formaldehyde and corrosive sublimate solution, or formalin, as follows: 61 rooms and 11 bath-rooms after 30 cases of diphtheria; 46 rooms and 6 bath-rooms after 34 cases of scarlet fever; 24 rooms after 23 cases of tuberculosis; also the 3 bath-rooms, basements, hallways and elevators of two apartment hotels after a case of the latter disease; 1 room each after fatal cases of typhoid fever, erysipelas and cancer; and 145 library books. He has also disinfected, upon recommendation of the attending physician, after 2 cases of measles, 2 of diphtheria exposure, 1 of tuberculosis, 1 of typhoid fever, and a quantity of clothing, books, etc., all of which was paid for by the parties for whom the work was done, when able to pay for it, if not, it was done at the expense of the health department.

Every milk wagon has been examined, and, when necessary, suggestions have been made as to the proper arrangement of boxes and compartments and the packing of milk bottles, with a view to prevent unnecessary noise, as well as to prevent contamination of milk and receptacles by contact with dirty cans, blankets, etc. A special circular on this subject was issued to milkmen August 1. Pressure has also been brought to bear upon owners of defective and noisy wagons, also upon noisy drivers, thereby stopping much unnecessary annoyance from this source.

Cambridge.

The most pressing need from the standpoint of preventive medicine is, and for years has been, a hospital with ample accommodations for cases of diphtheria, scarlet fever and measles. At the present time the diphtheria hospital can, when every bed is occupied, accommodate 19 patients. The Cambridge Hospital can accommodate, without overcrowding, 8 cases of scarlet fever. There is no place for the reception of cases of measles. This is a condition of affairs not creditable or humane in a city of 100,000 inhabitants. In case of a great outbreak of one of the diseases mentioned above, the board of health would be heavily handicapped in any effort to

limit the spread of that disease, as the most efficacious method for such limitation is the prompt isolation in hospital of the early cases. Though the outbreak of an infectious disease may not be attended by a large fatality, the amount of privation and misery it may entail on the poor is not easily to be estimated.

During the year the inspector of provisions believed it advisable to recommend to the board the passage of a regulation which would prevent exposing for sale, outside of stores or shops, meat, poultry, game or fish, and require the taking of proper precautions to prevent the accumulation of dust on the food so exposed, and also to ensure the preservation of the goods in warm weather. The good results received from the regulation which was passed by the board would make it seem advisable to include in a similar prohibition the method of selling dates and figs. At the present time these articles are often kept on stands outside of stores, and are exposed to any accumulations of dust or filth that may be blown about by the winds. It does not seem probable that food thus exposed is fit for consumption.

Medical Inspection of Schools. — The diseases discovered in the schools and the number of cases were as follows: —

Chicken-pox,	9
Measles,	16
Mumps,	21
Whooping-cough,	3
Pediculosis,	191
Diseases of ear,	24
Diseases of eye,	67
Diseases of nervous system,	12
Diseases of skin,	156
All other diseases,	217
Total,	716

CHICOPEE.

In cases of typhoid fever, investigations were made and information sought relative to the sources of water, ice and milk with which the patients were supplied during a period of two months ending with date of illness, in order to determine, if possible, where and how the disease was contracted. Several cases were reported, the causes of which were traced outside of the city.

FALL RIVER.

The number of cases of scarlet fever, diphtheria, typhoid fever, smallpox and all contagious and preventable diseases, reported for the year, are small compared with that of any previous year or with that of other Massachusetts cities as compared with the population.

This condition is due, in the opinion of the members of the board, to the

vigorous action taken in 1903, during the prevalence of the smallpox and typhoid fever outbreaks, when stringent measures were taken to stamp these diseases out, and keep them out if possible.

First. — By excluding milk from sale in the city from any suspected source, until satisfied beyond the possibility of a doubt that it could not convey the germs of any disease.

Second. — By assuming, under the rules of the State Board of Health, with the consent of the Watuppa Water Board, jurisdiction over the source of water supply of the city, to prevent the possibility of any pollution or contamination of the water of North Watuppa Pond and its tributaries by householders or in the harvesting of ice, and by prohibiting skating, boating, fishing, bathing, and washing clothes in the water, or holding picnic parties on the shore thereof. This has met with the almost unanimous approval of our citizens, including those who previously enjoyed the pastimes prohibited, and about the only criticism heard was surprise expressed that those precautions had not been taken years ago.

Third. — By a general vaccination in all the public, parochial and private schools in the city and the districts where smallpox appeared.

Fourth. — By a general medical inspection of all the schools in the city, and the fumigation that followed in schools and dwelling-houses supplemented by the sanitary inspections afterwards made and the subsequent cleaning up of premises found in need of it, which produced the best sanitary conditions obtained in the city for a number of years.

By an order adopted by the board a year ago, the vaccination of all persons is made compulsory under the provisions of the Public Statutes of the Commonwealth, and a certificate of successful vaccination is required as a prerequisite to entering any school in the city, with the result that there is practically no pupil attending any public or private school in the city who is not vaccinated or in possession of a certificate of exemption according to law under the regulation of the board of health.

Thorough vaccination is the best known preventative against the spread of smallpox if it should again appear, and there is, perhaps, no community more thoroughly fortified against the invasion of this disease, in this way, than the city of Fall River. 1,723 persons were vaccinated under the order above referred to during the past year.

Fitchburg.

In February, 1904, the board strengthened the efficiency of the quarantine regulations by passing the following votes: —

Voted, That rules 13 and 14 of the rules and regulations of the board of health shall apply to Sabbath schools and church services.

Voted, That the pastors and Sunday-school superintendents of the city be notified to the above effect.

By so doing, pupils in all the schools of the city are now placed under the same restrictions during the period of quarantine. Several superintendents of our Sunday-schools have expressed satisfaction on account of the advanced step taken in these matters by the board. As a result of this vote, whenever a scholar in any school is reported sick with a contagious disease, the superintendent of the Sunday-school which the scholar attends is notified of the fact, as well as the teacher in the day school, and the said scholar is not allowed to attend either public school or religious services until released from quarantine. At the same meeting the board adopted rules to be observed during quarantine, and to be posted in or near the door of the sick room.

The inspection of the houses in which occurred the 42 cases of diphtheria, croup, scarlet fever and typhoid fever, during 1904, showed the plumbing to be in poor condition in only one instance in a case of diphtheria and in one of typhoid fever. This bears out the previous observations of the board in regard to the relation of plumbing to contagious and infectious diseases.

Haverhill.

The routine work of the department has been similar to that of the previous years. There are not so many complaints of vaults and cesspools as there were a few years ago, and less unsanitary plumbing. Practically all the privy vaults (1,679 in all) and cesspools in sewered streets have been abolished, and water-closets with sewer connections have taken their place. The plumbing and house sewerage systems in fully two-thirds of the buildings in the city have been reconstructed and modernized since the passage of the plumbing ordinance.

Holyoke.

The board would once again call attention to the imperative need of a hospital for the care of diseases of a contagious nature, especially diphtheria and scarlet fever. The value of such institutions is being realized more and more each year, and many cities of the State now have such accommodations, which greatly aid in the control of epidemics of such diseases. With our large tenement districts, it is evident that we should have such a building at our command in the city.

The present pest-house in use by the city is well suited in most ways, and furnishes a very satisfactory as well as secluded place of confinement for persons suffering with smallpox. Improvements recommended last year should be made. A sanitary system should be arranged to remove the sewage from the building, and a satisfactory receptacle made for the same. A small addition should also be made to include a disinfecting room for those who are obliged to visit the building, and also a bath-room for the use of patients. These necessities are indispensable, and should receive immediate attention.

Leominster.

The board has hired a small room centrally located, and has begun fitting it up for laboratory work, has purchased many utensils and articles needed for its equipment, and will proceed to still further equip it as fast as it is needed.

We hope within a short time to have this equipped and a competent man installed who will be at all times available, so as to be able to fully examine any specimen left there by any physician in town, and the result given within a short time.

Lowell.

For failure to comply with the requirements of the statutes of the Commonwealth and the regulations of the board of health in regard to the burial of the body of a person dying with a contagious disease, an undertaker's license was revoked for one month. The particular offence was allowing a public funeral and permitting four young boys to act as bearers, in a case where the deceased died with diphtheria.

For allowing the father, who himself had diphtheria, to go in a public carriage to the cemetery for the burial of his child who had died with diphtheria, another undertaker's license was revoked for fifteen days.

These penalties were exacted for disciplinary purposes, the board feeling that the undertakers were becoming too careless concerning their responsibilities in preventing the spread of contagious diseases.

Lynn.

During the year 1904, from January 1 to December 31, there were admitted to the contagious disease hospital 83 cases of diphtheria and 25 cases of scarlet fever. One case in addition to the above mentioned was successfully treated for a complication of scarlet fever and diphtheria. There were no deaths from scarlet fever.

We now admit to the hospital patients suffering from erysipelas, who, for any reason, cannot be treated at home.

One thousand and sixty bottles of antitoxin, each containing 1,500 units, have been used in the treatment of diphtheria patients at the hospital during the year. Forty-six bottles have been used outside of the hospital for immunizing purposes.

Since the establishment of the laboratory, which enables us to determine with absolute certainty the quality of any given sample of milk, and whether it has been watered or adulterated in any way, frequent examinations have been made of the milk sold by our dealers and milkmen. Every store has been visited several times during the year, and samples taken for analysis. The milkmen are intercepted on their routes, and samples taken nearly every month. Should occasion require, samples are taken immediately,

and in each case a copy of the analysis of the chemist is furnished to the dealer or milkman, so they may know just the quality of the milk. Frequent inspections have been made of the dairies and milk rooms, especially in regard to their cleanliness, and also in respect to sanitary condition. During the year 348 visits have been made, and such information as was necessary given as to changes which should be made.

Malden.

The wisdom of the medical inspection of the public schools has been proved by the small number of the graver contagious diseases that have occurred during the year. All the schools are at present under sanitary supervision, and the board feels that the small expense for that work is justifiable. Over 1,300 suspected cases were examined by the physicians, and many excluded from the schools, thus preventing further contagion.

During the year the city government has voted for the erection of a contagious hospital, and we hope when it is in working order for a still further reduction in the number of contagious diseases.

New Bedford.

During the year, in compliance with statutory requirements, an isolation hospital has been erected. It should be equipped at once, and placed in readiness for the reception of patients. The board feels that the city is to be congratulated upon the possession of a hospital for the care of patients afflicted with diphtheria or scarlet fever, who, living in boarding-houses and large tenement blocks, endanger others, oftentimes being the means of causing epidemics of those diseases. We believe its usefulness will be better appreciated as the people become better acquainted with its conveniences, situated as it is in a most healthful locality, with an abundance of pure air.

Newton.

In the matter of free examination of specimens of sputum for the detection of tubercle bacilli, the recommendation of the department was reported upon favorably by the finance committee and passed by the board of aldermen. The department promptly prepared the necessary outfits for collecting specimens, and notified the physicians of the city that they could be obtained at the various culture stations after Jan. 1, 1905.

The department considers this a distinct step in advance, and one which helps to keep abreast of the steady advance in health work.

Too much stress cannot be laid upon the necessity of early treatment in diphtheria, as the mortality is in direct proportion to the delay in beginning treatment. With the exception of these cases, there was nothing remarkable about the occurrence of the disease during the year.

Milk Farms. — All milk farms in the city where more than seven cows are kept for the purpose of producing milk for sale have been inspected

monthly by the agent, and smaller farms have been inspected at frequent intervals. Most of the milk used in the city is produced on farms outside of the city limits, and the sanitary condition of many of these farms is far from satisfactory. No regular inspection of such farms is made by this department, and in some near-by communities there is a total lack of local oversight. This condition suggests the necessity of some general law providing for the supervision and control of milk producers.

The occurrence of suspicious cases of typhoid fever on the route of a dealer selling milk produced outside the city is always made the occasion of an examination of the producer's premises; and in this manner dangerous conditions have several times been discovered, and improvements insisted on in cases which would not otherwise come within the jurisdiction of this board.

North Adams.

In the regular routine of the work of the board there have been made during the year 637 quarantine inspections and fumigations, 69 milk inspections and 763 general inspections of houses and premises. Besides these, some hundreds of special inspections of houses and persons were made by the chairman and the physician of the board during the months from August to October inclusive.

The board would call attention to the marked diminution in the typhoid fever cases occurring in the city during the two years of office of the present board, the number for 1904 being 31. It was for the purpose of eradicating this disease from our city that we employed a physician to the board.

Northampton.

In March the attention of the board was called to the condition of the Robert's meadow water-shed. It was found that several farmhouse privies in this area drained almost directly into brooks which are part of Northampton's water supply, and that at one of these places a case of typhoid fever had recently occurred. At the request of this board the State Board of Health made regulations to prevent the pollution of Northampton's water supply, and, acting by the authority of these rules, the board of water commissioners have greatly improved matters; but Northampton will never be entirely free from the danger of typhoid epidemic until certain farms have been bought by the city.

Pittsfield.

We would recommend that the city consider the question of erecting some small building for the treatment of contagious diseases. The city is called upon to care for many cases of diphtheria, smallpox and scarlet fever, by reason of a lack of means in the families of the patients. Maintaining an effective quarantine is often difficult, and the expense of food, medicine and

repayment for articles necessarily destroyed when quarantine is raised is often large. We think that a small detention building would prevent the spread of contagion, and enable the city to handle its cases at less expense.

Provincetown.

The past year has been a very favorable one as regards the health of the community, a very few cases of contagious diseases having occurred. A number of cases of diphtheria were reported, and the dwellings wherein the cases occurred were promptly placed under quarantine. The local physicians attending the same were furnished with culture tubes and antitoxin received from the State Board of Health, so that the disease, which at one time threatened to become epidemic, was stamped out, and all danger for the time being was averted, no case proving fatal. No other contagious disease has been reported to us during the past year.

Quincy.

This year, as in past years, the board has endeavored to carry out the work of improvement of the city's sanitary condition through the enactment and enforcement of the rules and regulations. Having that object in view, our efforts have been rewarded in a measure, and we note with satisfaction a decrease in contagious diseases over previous years. The number of cases of infectious diseases reported to the board of health the past year has been less than in the previous year. The death rate, based on the estimated population, has been 12.57 per thousand, as against 13.51 in 1903.

Rules regulating barber shops have also been enacted, copies of which have been posted in every shop, that the public may know what is required from barbers in the way of cleanliness and hygiene.

The collection of garbage has been done in as satisfactory a manner as could be expected, with the limited means at hand. The various locations known as "dumps" have been inspected at intervals and kept free from nuisance.

The bakery shops have also been inspected, and made to comply with the statutes as much as practicable.

The following licenses were issued by this board in 1904: plumbers, 32; undertakers, 6; scavenger, 1; garbage, 30.

Salem.

During the year the board visited Hyde Park, and, after inspecting their system of collecting swill in metal barrels, caused a team to be put on for the same purpose in Salem. The idea promises to sólve much of the trouble about unloading upon the city dump, and will for most of the year (except

ing very cold weather) be a good thing. A second team is now being similarly constructed, and two horses have been purchased.

In the city there are 24 bakeries, large and small, 25 per cent. of which are considered by the inspector of the board as not fit places for the manufacture of food; another 25 per cent. are in fair shape, and the balance in good condition. According to the conditions as a whole throughout the city, a beginning was made none too soon to bring about proper sanitary conditions in these places. Even now, after a number of warnings, some of the bakers have not tried to any extent to bring their places within the scope of the statute. There is much difficulty for some of them to literally comply with the law, because they are located in cellars, or in old and dilapidated buildings that are practically beyond repair. These places, unless radically changed, should be condemned, and the proprietors compelled to locate in more suitable buildings.

Southbridge.

In common with many other towns and cities of the State, we have had an epidemic of diphtheria during the season. One hundred and eighty-six cases have been reported, with 18 deaths. It is significant that more than two-thirds of the fatal cases were those who had no medical attendance, or in which a physician was not called until the patient was beyond help. It is practically certain that, had these cases been reported promptly, a number of valuable lives would have been saved. We hope the public will more and more realize the need and value of sanitary work, and give the board its hearty assistance in its efforts to render the town clean and free from contagion.

Springfield.

More important, probably, than the laboratory examination of milk, is the oversight of the conditions under which milk is produced at the farm. It is the intention of the board to take every precaution to exclude from the city milk that is not produced under safe conditions, to say the least, and to very greatly improve the conditions as to cleanliness in all things relative to the actual collection and care of the milk before and after it is brought to the city.

Medical Inspection of Schools. — The board of health has been in favor of the medical inspection of schools in this city for a long time, and has known of the interest of the school board in this connection. The matter has been agitated recently, and it is hoped that arrangements may be made the coming year so that either this board or the school board may be enabled by the means of a suitable appropriation to take up this important work. During the last few months case after case of illness of one sort or another has been referred to the board of health office or to the health physician by

school teachers, for diagnosis, treatment and advice. While the board does not consider that the ordinary contagious diseases are spread by means of the school, personal visits to the schools show that there are cases constantly coming to the teachers' notice which demand medical advice. Contagious skin diseases are not at all uncommon in the schools, and the teachers cannot be expected to promptly or properly realize the nature of these affections.

During the latter part of the week ending December 24, several cases of scarlet fever were reported from the upper residential portion of the city. Investigation showed that the families in question took milk from the same milkman. It should be stated at this point that the last known case of scarlet fever in this city previous to this was that of a small child who was removed to the isolation hospital from a tenement house in one of the poorer portions of the city on November 22. This child had recovered and been sent home before the outbreak in question began. There was, therefore, so far as known, no scarlet fever in the city at the time of this outbreak, nor could it be connected in any possible way with the case just described. Investigation also showed no cases of illness among those having to do with the milk on this route. Cases continued to be reported, however, during the succeeding week, and a further investigation was carried on, taking the form of a personal inspection of the hands and feet of those having anything whatsoever to do with handling the milk. The milk cans were washed at a place other than where the milk was produced, and no sign of any contagion was found at this point. The dairy was found to be in excellent condition, managed by a firm much interested in keeping their place neat and clean. No cases of sickness were found here, but the last person to be examined, a young man of about twenty-three, showed peeling on the hands and feet. Careful questioning brought about the facts that about the first of December this man had a sore throat for two days, but during this time he kept at work, missing none of his meals, nor did he confess to having been sick in any other way. This man was then sent to the isolation hospital, where he remained four weeks, desquamating freely. The dairyman, although somewhat skeptical at first that this was the cause of the infection among his customers, was soon convinced of the truth of the matter, and did everything in his power to assist the board of health in preventing further spread of the disease. He marketed no milk, by order of the board, from December 29 until January 13, a period of fifteen days, and during this time the dairyman's house was thoroughly fumigated, all the barn implements and utensils used in connection with the milk washed in hot water and disinfected, the stable whitewashed and the cows washed twice.

In all 31 cases of scarlet fever occurred in families taking milk from this one dairyman, these cases being reported between the dates of December 20 and January 3. The disease subsided very promptly after the supply

of milk from this source was stopped, and during this period of two weeks but one other case of scarlet fever not on this route was reported, and that seemed to be a case secondary to the one already reported. The disease in each case ran a comparatively mild course, but there was a marked degree of peeling in many cases. No fatalities resulted. The average period of isolation was five weeks.

A consideration of the number of families served by this dairyman showed that, of the total number of cases of scarlet fever at this time, there were six families in which more than one member was attacked. It appeared that most of the families affected were served with the morning's milk. This fact cannot but suggest the possibility of a rather hasty toilet in the morning before proceeding to milk the cows. In conclusion, it seems evident that the cause of this scarlet fever epidemic was due to the use of milk unmistakably infected by the milker milking with freely desquamating hands.

Waltham.

A general inspection of the dairies in this city and of several of those in neighboring towns from which a portion of our milk supply is derived has been made during the year, and, while the conditions surrounding the production of this important article of food were found to be reasonably satisfactory, yet there is room for improvement.

In several places milk is stored in rooms within or adjoining the cow barn, where, during the process of cooling and until tightly sealed within the cans for delivery, it is exposed to the prevailing atmosphere of the barn. As milk is known to be a ready absorbent of gases, it should be removed as soon as drawn to an atmosphere as nearly pure and free from all odors as the most sanitary surroundings will produce.

Watertown.

Much work has been done during the past season in cleaning up stagnant pools, ponds and brooks. In this connection the Board gave its attention to the suppression of the mosquito nuisance. There are in the town some fifteen ponds, large and small, which were cleaned up and treated with crude petroleum. In addition to the ponds, the catch-basins connected with the drainage system were treated several times. These are prolific breeding places for the mosquito during the warm months.

Worcester.

The good work of the isolation hospital has continued during the past year. Last year we reported the remarkably low mortality rate of 3.8 per cent. for diphtheria treated at the hospital. This year we have great pleasure in reporting that the rate of mortality has been reduced to 1.4 per cent.; that is to say, of 67 cases treated, many of them severe, only 1 died.

Proportion of Cases reported in the City which were treated at the Hospital.

	Diphtheria (Per Cent.).	Scarlet Fever (Per Cent.).		Diphtheria (Per Cent.).	Scarlet Fever (Per Cent.).
1897, ...	20.80	7.00	1901, ...	33.80	28.89
1898, ...	23.90	9.70	1902, ...	46.25	21.68
1899, ...	29.70	17.70	1903, ...	46.33	20.23
1900, ...	38.30	27.20	1904, ...	61.49	28.57

Mortality Rate for Diphtheria, by Years.

1897, ...	8.57	1901, ...	7.77
1898, ...	8.69	1902, ...	5.79
1899, ...	7.20	1903, ...	3.84
1900, ...	8.00	1904, ...	1.49

The gradual drop in our mortality rate for diphtheria, as shown in the above table, is very gratifying. It also signally proves the great value of antitoxin, for, while all other conditions and methods of treatment have been practically unchanged during these eight years, the death-rate has decreased in direct ratio to the increased dosage of serum. We believe that the conditions which exist here for demonstrating the efficacy of the remedy are particularly good, and make the statistics valuable, even though the numbers treated are not great.

In the first place, the patients are placed under ideal hygienic conditions made possible by the situation of the hospital. Sunlight and fresh air are unrestricted. Then all local treatments, which harass and exhaust the patients, are abandoned, and we simply rely upon the serum to combat the disease. During convalescence patients are guarded by rest in bed and a restricted diet until nature has had time to repair the injured tissues. We emphasize this treatment because of the unfortunate prejudice which seems to still exist in the public mind against antitoxin. The average dosage per patient the past year has been 11,085 units. The largest amount any one person received was 42,000 units, and was given in 6,000 unit doses every six hours. Three thousand units was the minimum amount. Rashes of greater or less severity were very common during the first part of the year, but during the last three months scarcely any have been seen. These are due, we believe, to the irritating properties of one particular lot of serum. The only death from diphtheria was due to pneumonia complicating the disease in an infant one year old.

Record of Visits made to Cities and Towns by Dr. Frank L. Morse, Medical Inspector, for the Purpose of investigating 51 Cases suspected of being Smallpox during 1904.

Case No.	City or Town.	Date.	Sex.	Age.	Character.	Successfully vaccinated.	Remarks.
1	Lawrence, .	Jan. 6,	M.	12	Discrete, .	No, ...	Ill January 2. Eruption January 5. Eruption in papular stage.
2	Lawrence, .	Jan. 11,	M.	25	Discrete, .	No, ...	From Somerset, Vt., where smallpox existed December 27. Ill January 7. Eruption January 9. Eruption in papular stage.
3	Maynard, .	Jan. 16,	M.	6	-	Two years ago.	
4	Maynard, .	Jan. 16,	F.	8	-	Two years ago, .	Diagnosis, chicken-pox.
5	Lawrence, .	Jan. 28,	M.	28	Discrete, .	January 14, . .	Exposed by case No. 2, January 10, 11. Ill January 22. Eruption 25th. Eruption in vesicular stage.
6	Newburyport, .	Jan. 29,	M.	27	-	Two years ago, .	Diagnosis, chicken-pox.
7	Lee, . . .	Feb. 8,	M.	2	Confluent,	No, ...	Ill January 29. Eruption 30th. Eruption in pustular stage. Infected by a case from Hudson, N. Y., who was taken ill on January 15. Died 22d.
8	Lee, . . .	Feb. 8,	M.	6	Discrete, .	No, ...	Ill January 29. Eruption 30th. Eruption in crust stage. Infected by a case from Hudson, N. Y., who was taken ill on January 15. Died 22d.
9	Lee, . . .	Feb. 8,	F.	30	Discrete, .	No, ...	Ill January 28. Eruption 30th. Eruption in crust stage. Infected by a case from Hudson, N. Y., who was taken ill on January 15. Died 22d.
10	Milford, . .	Feb. 19,	F.	16	Discrete, .	No, ...	Ill February 10. Eruption 13th. Eruption in pustular stage.
11	Milford, . .	Feb. 19,	M.	41	Discrete, .	Infancy, . . .	Ill Dec. 28, 1903. Eruption 29th. Remains of smallpox eruption on face and body.
12	Milford, . .	Feb. 19,	M.	4	Discrete, .	No, ...	Ill January 10. Remains of smallpox eruption on face and body. Unrecognized case.
13	Milford, . .	Feb. 19,	F.	14	Discrete, .	Four years ago, .	Ill January 15. Remains of smallpox eruption on face and body. Unrecognized case.
14	Milford, . .	Feb. 19,	M.	20	Discrete, .	No, ...	Ill January 20. Remains of smallpox eruption on face and body. Unrecognized case.
15	Wellesley, .	Feb. 25,	F.	21	-	Fourteen years ago,	Diagnosis, chicken-pox.
16	Hopedale, .	Feb. 26,	M.	16 months,	-	No, ...	Diagnosis, scarlet fever.
17	Hopedale, .	Feb. 27,	F.	33	-	Infancy, . . .	Diagnosis, erythema multiform.
18	Chester, . .	Mar. 1,	F.	17	-	Ten years ago, .	Diagnosis, chicken-pox.
19	Chester, . .	Mar. 1,	M.	26	-	Eleven years ago, .	Diagnosis, chicken-pox.

Record of Visits made to Cities and Towns by Dr. Frank L. Morse, Medical Inspector, for the Purpose of investigating 51 Cases suspected of being Smallpox during 1904 — Concluded.

Case No.	City or Town.	Date.	Sex.	Age.	Character.	Successfully vaccinated.	Remarks.
20-25	Randolph,	Mar. 4,	M., F.	2-14	-	- -	Diagnosis, scabies.
26	Fall River,	Mar. 21,	F.	14	-	Two years ago,	Diagnosis, rheumatism.
27	Pittsfield,	Mar. 24,	M.	45	Discrete,	No,	Ill March 12. Eruption 14th. Eruption in crust stage.
28	Lowell,	Mar. 28,	M.	7	Discrete,	No,	Ill March 21. Eruption 24th. Eruption in vesicular stage. Father ill with smallpox from March 7 to 21.
29	Pittsfield,	April 9,	M.	22	Discrete,	No,	Exposed to case No. 27 on March 19. Ill March 31. Eruption April 3. Eruption in pustular stage.
30	Lynn,	April 29,	M.	9 months,	-	No,	Diagnosis, chicken-pox.
31	Leominster,	May 1,	F.	34	Discrete,	No,	Ill April 21. Eruption 25th. Eruption in pustular stage.
32	Marlborough,	May 6,	M.	9	-	- -	Diagnosis, scabies.
33	Watertown,	May 7,	M.	27	-	Two years ago,	Diagnosis, chicken-pox.
34	Monroe,	May 20,	F.	30	Discrete,	Infancy,	Landed at New York from Harve May 2. Ill May 10. Eruption 14th. Eruption in pustular stage.
35	Natick,	June 6,	M.	25	-	Two years ago,	Diagnosis, chicken-pox.
36	Lawrence,	June 8,	M.	25	Discrete,	No,	Ill May 31. Eruption June 4. Eruption in pustular stage.
37	Lawrence,	June 20,	M.	35	Discrete,	Twenty years ago,	Ill June 12. Eruption 15th. Eruption in vesicular stage.
38	Lanesborough,	June 22,	M.	18	-	No,	Diagnosis, chicken-pox.
39	Dedham,	June 23,	F.	19	-	Infancy,	Diagnosis, impetigo contagiosa.
40	Fitchburg,	July 8,	F.	28	Discrete,	Sixteen years ago,	From Canada July 1. Eruption July 2. Eruption in crust stage.
41	Fitchburg,	July 18,	F.	2	Discrete,	July 6,	Vaccinated after exposure to case No. 40. Eruption in pustular stage with no constitutional disturbance.
42	Lowell,	July 22,	M.	33	-	Infancy,	Diagnosis, erythema multiform.
43	Lawrence,	Aug. 12,	F.	15	Discrete,	No,	Ill July 29. Eruption August 2. Eruption in crust stage.
44	Lawrence,	Aug. 12,	M.	28	Discrete,	No,	Ill July 9. Eruption 13th. Remains of smallpox eruption over face and body. Unrecognized case, infecting case No. 43.

45	Lowell, . .	Sept. 20,	M.	17	Discrete, .	Ten years ago, .	Ill September 14. Eruption 17th. Eruption in vesicular stage.
46	Waltham, .	Sept. 23,	F.	5	-	Two years ago, .	Diagnosis, impetigo contagiosa.
47	Wareham, .	Sept. 26,	M.	20	-	Six months ago, .	Diagnosis, typhoid fever.
48	Fitchburg, .	Sept. 29,	M.	70	Confluent,	Infancy, . . .	From North Adams September 21. Ill 25th. Eruption 27th. Eruption in vesicular stage.
49	Westfield, .	Oct. 1,	F.	3	-	No, ...	Diagnosis, urticaria.
50	Westfield, .	Oct. 1,	M.	2	-	No, ...	Diagnosis, urticaria.
51	Randolph, .	Oct. 13,	F.	6 months,	-	No, ...	Diagnosis, chicken-pox.

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PUBLIC DOCUMENT . . . . No. 56.

ELEVENTH ANNUAL REPORT

OF THE

BOARD OF REGISTRATION IN MEDICINE.

FOR THE YEAR ENDING DEC. 31, 1904.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1905.

Approved by

The State Board of Publication.

Commonwealth of Massachusetts.

BOARD OF REGISTRATION IN MEDICINE,
STATE HOUSE, Dec. 31, 1904.

To His Excellency JOHN L. BATES, *Governor*.

SIR: — The number of persons applying for registration this year is 403, all of whom have been examined except 9. The number of applicants on the rejected lists who have been re-examined is 92, a small percentage of whom have secured registration. The whole number of individual examinations given this year is 486. The results are given in tabulation as follows: —

	Examined.	Registered.	Rejected.	Percentage rejected.
March examination,	67	49	18	27
May examination,	47	29	18	39
July examination,	214	173	41	19
September examination,	90	67	23	39
November examination,	68	41	27	40
Totals,	486	359	127	32.8

The following tabulated data apply only to results in first examination of applicants: —

NAME OF INSTITUTION.	Number examined.	Number registered.	Year of Graduation of Rejected Applicants.
Harvard University,	94	94	
Tufts College,	41	36	1896-99-04-04-04.
Baltimore Medical,	21	16	1903-04-04-04-04.
University of Vermont,	18	15	1898-04-04.

Name of Institution.	Number examined.	Number registered.	Year of Graduation of Rejected Applicants.
Boston University,	15	15	
Physicians and Surgeons, Boston,	14	10	1902-04-04-04.
Physicians and Surgeons, New York,	13	12	1892.
Foreign,	12	9	1878-87-99.
Physicians and Surgeons, Baltimore,	10	9	1903.
Jefferson,	9	8	1885.
Woman's Medical, Pennsylvania,	9	9	
Baltimore University,	8	1	1897-1902-03-03-04-04-04.
Maryland Medical College,	7	2	1903-04-04-04-04.
Kentucky School of Medicine,	5	2	1903-04-04.
Georgetown University,	5	5	
Laval,	5	2	1903-04-04.
McGill,	4	4	
Dartmouth,	3	3	
University of Maryland,	3	2	1904.
Albany Medical,	3	1	1892-93.
Yale,	3	3	
University of the South,	3	1	1903-04.
Bowdoin,	2	2	
University of Pennsylvania,	2	2	
Cornell,	2	2	
University of Michigan,	2	2	
Detroit Medical,	2	2	
Hahnemann, Pennsylvania,	1	1	
New York University and Bellevue Hospital,	1	1	
University of New York,	1	1	
Bellevue Hospital Medical College,	1	-	1894.
University of Louisville,	1	1	
Pulte Medical,	1	-	1902.
Ensworth Medical,	1	1	
Ohio University,	1	1	
Hahnemann, Chicago,	1	1	
Barnes Medical,	1	-	1898.
Medical College of South Carolina,	1	1	
Physicians and Surgeons, St. Louis,	1	-	1896.
Vanderbilt,	1	-	1890.
Miami Medical,	1	1	
Laura Memorial,	1	1	

Tabulation showing number and average rating of graduates from the following medical schools represented by not less than three applicants: —

Name of Institution.	Number examined.	Average Rating.
Harvard University,	94	76.6
Tufts College,	41	73.3
Baltimore Medical College,	21	67.7
University of Vermont,	18	74.2
Boston University,	15	76.2
Physicians and Surgeons, Boston,	14	71.3
Physicians and Surgeons, New York,	13	69.1
Foreign,	12	69.4
Physicians and Surgeons, Baltimore,	10	74.0
Jefferson,	9	71.1
Woman's Medical College, Pennsylvania,	9	74.4
Baltimore University,	8	56.7
Kentucky School of Medicine,	5	64.4
Georgetown University,	5	75.8
Laval,	5	67.5
McGill,	4	76.0
Dartmouth,	3	77.9
University Maryland,	3	74.4
Yale,	3	79.4
University of the South,	3	70.8
Albany Medical College,	3	59.6

The number of applicants examined in November, the last examination during the year, was 68, of whom 41 passed and 27 failed. The number of undergraduates in the class was 23, of whom 8 passed and 15 failed. The institutions represented, year of graduation and ratings were the following: —

COLLEGE.	PASSED.	
	Year of Graduation.	Per Cent.
Harvard University,	1880	85.0
Harvard University,	1891	80.6
Harvard University,	1904	81.6-83.3-70.6-77-78.6-80.5
Harvard University,	Undergraduates.	70.8-70.5-84.1-78.6
Tufts College,	1900	74.5
Tufts College,	1904	75.5-73-70.6-74.1-72.2
Boston University,	1903	80.3
Physicians and Surgeons, Boston,	Undergraduates.	72.3-73.1
McGill,	1897	74.5
McGill,	1901	77.8
McGill,	1903	74.6
Laval,	1904	72.5
Jefferson,	1904	80.6
Woman's Medical College, Pennsylvania,	1903	78.0
University of Vermont,	1904	80.3
University of Vermont,	Undergraduate.	75.1
Maryland Medical College,	1904	70.5
Baltimore University,	1904	70.2
Physicians and Surgeons, Baltimore,	1904	78.3
Georgetown University,	1904	76.8
Physicians and Surgeons, Columbia College,	1898	84.3
Physicians and Surgeons, Columbia College,	1903	77.5
University of the South,	1902	70.2
Kentucky School of Medicine,	1903	70.0
Detroit College of Medicine,	1904	72.5
University of Naples,	1903	80.5
University of Catania,	1902	78.8
Osteopathic School,	-	70.5

COLLEGE.	FAILED.	
	Year of Graduation.	Per Cent.
Harvard University,	Undergraduates.	63.1-63-64.8
Tufts College,	1896	57.5
Tufts College,	Undergraduates.	58-63-67
Physicians and Surgeons, Boston,	1904	64.1
Physicians and Surgeons, Boston,	Undergraduates.	68.5-68.8-68-42.8-18.3-61.5
University of Vermont,	1904	61
Baltimore University,	1897	56.1
Baltimore Medical College,	1904	62.1-65.2
Baltimore Medical College,	Undergraduate.	56.6
University of the South,	1904	67
Kentucky School of Medicine,	1904	65.1-54
New York Homœopathic Medical College,	Undergraduate.	57
Barnes Medical College,	1898	48.8
Royal College Physicians and Surgeons, Edinburgh,	1878	54.8
Osteopathic School,	–	59-66.3

The examination questions were the following: —

Describe the formation of the deep and the superficial palmar arches.

Name and describe the salivary glands.

Locate and give the relations of the right kidney.

Classify muscles, and describe each class macroscopically and microscopically.

Describe the crystalline lens, and give its relations.

Describe the peritoneum, and name the organs covered completely by it.

Describe the periosteum.

Name the organs and parts of organs located in the left hypochondriac region.

Mention six or more disinfectants. State best methods of disinfecting rooms and contents of same, after exposure to contagious diseases.

When are diseases said to be epidemic, and when endemic? What diseases usually render a person immune from a second attack?

What foods best maintain animal heat in cold climates? Give reasons for your answer.

What are the constituents of arterial blood? By what process is venous blood changed into arterial?

By what processes is drinking water purified? Describe each.

What is carbon dioxid? What are its properties and uses?

What is an alkaloid? Name three much used in medicine.

Explain the anatomic and physiologic differences, and the function of the following: mucous, serous and synovial membrane.

How is the sensation of pain produced?

State the normal reaction, and the cause of the same in each of the following: gastric juice, pancreatic juice, bile, urine and blood.

Name the excretory glands of the body and their functions.

What are the functions of the pneumogastric nerve?

Describe the pathologic characteristics of dry gangrene.

Define cloudy swelling. Describe its pathologic process in the kidney.

In what pathologic lesions is urea in the urine diminished?

Give size, form, color and constituents of biliary calculi, their location, and the lesions they may produce.

Give the morbid anatomy of endocarditis.

Discuss furuncle from a pathologic standpoint.

Discuss the pathologic characteristics of naso-pharyngeal adenoids.

Differentiate pathologically the lesions of catarrhal, aphthous and ulcerative stomatitis.

Describe cystic tumors, and give the varieties.

Discuss the pathology of Addison's disease.

Discuss tubercular cervical glands, — etiology, diagnosis and treatment.

Describe, and state treatment of dislocations of the knee joint.

Diagnose fracture of the patella. State varieties and treatment.

Diagnose nasal polypi. State etiology, symptoms and surgical treatment.

Give the varieties of dislocation of the shoulder joint, and state mode of reduction of any one.

Define strabismus. State its cause, and describe operation for its correction.

What is circumcision; how performed, and what are the indications for it?

Give diagnosis and treatment of gonorrhea in the male.

Differentiate concussion and compression of the brain.

What conditions would contra indicate general anesthesia? What conditions would influence you as to choice of an anesthetic?

Name three causes of persistent hæmorrhage following labor, and treatment in each case.

What is the significance of ante-partum hæmorrhage?

How do you render your obstetric and gynecologic instruments aseptic?

What is Trendelenburg's posture? Describe a case when this posture would be advantageous. What are the dangers incident thereto?

Differentiate pregnancy of five to seven months and an ovarian cyst.

State briefly what changes take place in the organs of reproduction at the time of the menopause.

What are the dangers of the Credé method of removing the placenta?

Discuss the management in a case of flat or inverted nipples; also cracked nipples. State the hygienic precautions necessary in such cases.

What are the causes of precipitate labor? What are the dangers in such cases, and how should they be managed or treated?

State the causes of transverse presentation, how such cases are diagnosed, and how managed.

Give diagnostic symptoms of poisoning by strychnine. In treating a case, what antidotes should be employed?

Define the term incompatibility as used in medicine, and give two examples.

Mention three cardiac stimulants, and state the adult dose, and best methods of administration of each.

State symptomatology and treatment of apoplexy due to cerebral hæmorrhage.

Give in detail the therapeutic uses of water.

Name two chronic diseases in which a daily rise in temperature is likely to occur. Give diagnosis and treatment of one.

Name the chronic diseases of the liver, and give diagnosis and treatment of any one.

Give the etiology, symptomatology, treatment and prognosis in scorbutus in infants.

What complications are liable to occur in measles, in scarlatina and in diphtheria? What prophylactic measures would you employ?

Describe and give treatment for rachitis in infancy.

The regular meetings for the examination of applicants begin on the second Tuesday in March, July and November, at 9.30 A.M., and close on the afternoon of the following day. Special meetings are held in May and September, on corresponding days and hours.

Applicants are admitted to examination by an "examina-

tion ticket," stating the applicant's number and the date of the examination. Tickets are issued to applicants on filing their applications; also to persons entitled to a re-examination, if application therefor is made not later than five days before the examination date.

The examinations are conducted in writing, in the English language, and are intended to be "sufficiently thorough to test the applicant's fitness to practise medicine." In each of the examinations held this year sixty questions, divided into sets of ten, have been given, and two hours allowed in which to answer each set. The applicant is required to designate his papers not by his signature, but by the number given to his application when filed. This requirement insures an incognito rating of his entire examination work.

The subjects on which the examinations are principally conducted are anatomy, hygiene, physiology, pathology, surgery, obstetrics, gynecology, diagnosis and practice.

When the general average of the ratings given the several sets of papers of an applicant by the individual examiners is below 70 per cent., his examination is regarded as unsatisfactory. If, however, one's general average is found to be near the minimum requirement, his papers are reviewed by the Board in general session, and his ratings fixed by a consensus of opinion.

Applications for an examination should be filed at least five days before the examination date, and must be made upon blanks furnished by the Board, signed and sworn to by the applicant, and must be accompanied by the required fee, which is twenty dollars. Certificates of registration in other States, or diplomas of graduation from medical colleges, do not exempt from an examination. Upon this point the law is mandatory, — *that all must be examined.*

A person refused registration by reason of failure to pass a satisfactory examination is entitled to two re-examinations within one year from the date of his first failure, without filing a new application or paying an additional fee.

Since the organization of this department, in July, 1894, the Board has issued 7,440 certificates of registration. Of this number, 3,792 were issued prior to January, 1895, during the

six months next following the organization of the Board, to practitioners residing in this Commonwealth at the time the registration act became in part operative. These practitioners were registered in two classes, and are designated in the annual reports of the Board as Class A and Class B. Class A includes graduates of medical institutions authorized by law to confer degrees in medicine, who were residing or practising in the Commonwealth at the time of the passage of the law; Class B includes non-graduate practitioners, who had practised medicine in the Commonwealth continuously during the three years next prior to the passage of the law. There were 3,443 names enrolled in Class A and 349 in Class B. There were 608 persons refused registration during the six months above referred to, they being unable to meet the requirements of the law as to graduation, or as to three years of continuous practice.

The work of registration under written examinations, conducted by the Board as required by law, began with the year 1895. Since that time the Board has given 4,797 individual examinations, and has issued 3,646 certificates of registration, — an annual average of 364. The number of unsatisfactory examinations is 1,157, — an annual average of 115.

The number of registered physicians now in practice in the Commonwealth is approximately 4,800, — an average of 1 to every 625 inhabitants.

The last part of section 9 of chapter 76 of the Revised Laws, beginning with the words "nor to registered pharmacists," is frequently misunderstood, or misapplied, due to the fact, no doubt, that the force of the proviso in the last line of the section is not strictly regarded. Clearly it was not the intention of the Legislature to exempt the several classes of persons mentioned in this part of the section from the general provisions of the law, only so far as they may be able to perform certain functions without infringing upon the terms of section 8. It is well understood that there are certain acts relating to the treatment of the sick which osteopaths, so called, or massagists, etc., may perform without holding themselves out as practitioners of medicine, or without being considered as practising medicine within the meaning of the law; for instance, rendering certain services to the sick, or administering

treatment generally under the direction of, or as advised by, attending physicians. But such services do not require the sanction of law. Inasmuch, therefore, as this part of section 8 does not confer special rights or privileges on the classes mentioned therein, it would be wise for the Legislature to repeal it, in order to avoid any possible misapprehension regarding it.

The word "medicine," as used in the registration act, is susceptible of but one meaning, namely, "the science which relates to the prevention, cure or alleviation of disease." The law does not consider methods or systems of practice, whether one does or does not make use of drugs in treating patients. Practising medicine within the meaning of the law is diagnosing disease and treating the same; and a practitioner of medicine is one who makes it his business so to do. Not infrequently, however, certain practitioners claim that they are not practitioners of medicine because in their practice they use no medicine. Notwithstanding the absurdity of such a claim, it is often used to distract and hinder court proceedings in prosecution cases.

Just what constitutes the practice of medicine, or holding one's self out as a practitioner of medicine, is clearly set forth in the medical practice laws in many of the other States. Such definitions have their advantages; possible misinterpretations of the intended meaning of the terms of the law are thereby avoided; its administration is simplified, and more certain as to results; and violations of it are less likely to occur.

The enactment of the following is recommended: —

Any person shall be regarded as practising medicine within the meaning of section eight of chapter seventy-six of the Revised Laws who shall publicly assume or advertise the title "Dr.", or "Physician", or any other title or designation which shall show or tend to show that the person publicly assuming or advertising the same is a practitioner of medicine in one or more of its branches; or who shall investigate or diagnose physical ailments, defects or conditions of any person with a view to treat or relieve the same by any method or system of practice, whether with or without the use of drugs; or who shall conduct a dispensary practice, or shall practise in a med-

ical institute, remedy or medical company, or place of business, wherein a person may be treated or receive treatment or relief for any real or supposed physical ailment, defect or condition.

The Board desires to call the attention of the Legislature to the small salaries received by its chairman and secretary, and to recommend that the same be duly considered and adjusted. In this connection it should be noted that the receipts of the Board, which are paid into the treasury of the Commonwealth, exceed annually the cost of Board maintenance by twelve to fifteen hundred dollars.

FINANCIAL STATEMENT.

Expenditures.

Services of members of Board,	$4,299 96	
Incidental expenses of Board,	408 06	
Investigation of complaints,	138 95	
Clerical service,	780 00	
Printing and material,	112 58	
Books and other office supplies,	217 26	
Postage, expressage and telephone,	181 90	
		$6,138 71

Receipts.

Fees paid into the treasury of the Commonwealth,	$7,820 00

Appendix A contains the law relating to registration, and court opinions on matters relating to the "meaning of the statute;" Appendix B, the names of all the practitioners registered in this Commonwealth.

Respectfully submitted,

C. EDWIN MILES, *Chairman.*
EDWIN B. HARVEY, *Secretary.*
WALTER P. BOWERS.
SAMUEL H. CALDERWOOD.
AUGUSTUS L. CHASE.
NATHANIEL R. PERKINS.
AUGUSTUS C. WALKER.

APPENDICES.

Appendix A.

Law relating to the Registration of Physicians.

[Revised Laws, Chapter 76, Sections 1-9.]

Section 1. There shall be a board of registration in medicine consisting of seven persons, residents of this commonwealth, who shall be graduates of a legally chartered medical college or university having the power to confer degrees in medicine, and who shall have been for ten years actively employed in the practice of their profession. No member of said board shall belong to the faculty of any medical college or university, and no more than three members thereof shall at one time be members of any one chartered state medical society. One member thereof shall annually in June be appointed by the governor, with the advice and consent of the council, for a term of seven years from the first day of July following.

Section 2. Said board shall hold regular meetings on the second Tuesday of March, July and November in each year, and additional meetings at such times and places as it may determine. At the regular meeting in July, it shall organize by the choice of a chairman and secretary who shall hold their offices for the term of one year. The secretary shall give a bond to the treasurer and receiver general in the penal sum of five thousand dollars, with sufficient sureties to be approved by the governor and council, for the faithful performance of his official duties.

Section 3. Applications for registration shall be made upon blanks to be furnished by the board, and shall be signed and sworn to by the applicants. Each applicant for registration shall furnish satisfactory proof that he is twenty-one years of age or over and of good moral character and, upon payment of a fee of twenty dollars, shall be examined by said board. If he is found by four or more members thereof to be twenty-one years of age or over, of good moral character and qualified, he shall be registered as a qualified physician and shall receive a certificate thereof signed by the chairman and secretary. An applicant who fails to pass an examination satisfactory to the board, and is therefore refused registration, shall be entitled within one year after such refusal to a re-examination at a meeting of the board called for the examination of applicants, without the payment of an additional fee; but two such re-examinations shall exhaust his

privilege under his original application. Said board, after hearing, may by unanimous vote revoke any certificate issued by it and cancel the registration of any physician who has been convicted of a felony or of any crime in the practice of his profession. All fees received by the board shall, once in each month, be paid by its secretary into the treasury of the commonwealth.

[SECTION 4.* Each member of the board shall receive ten dollars for every day actually spent in the performance of his duties, and the necessary travelling expenses actually expended in attending the meetings of the board, not exceeding three cents a mile each way. Such compensation and the incidental and travelling expenses shall be approved by the board and paid by the commonwealth only from the fees paid over by the board.]

SECTION 5. The board shall keep a record of the names of all persons registered hereunder, and of all money received and disbursed by it, and a duplicate thereof shall be open to inspection in the office of the secretary of the commonwealth. Said board shall annually, on or before the first day of January, make a report to the governor of the condition of medicine and surgery in this commonwealth, of all its official acts during the preceding year and of its receipts and disbursements.

SECTION 6. The board shall investigate all complaints of the violation of the provisions of section eight, and report the same to the proper prosecuting officers.

SECTION 7. Examinations shall be wholly or in part in writing in the English language, and shall be of a scientific and practical character. They shall include the subjects of anatomy, surgery, physiology, pathology, obstetrics, gynecology, practice of medicine and hygiene, and shall be sufficiently thorough to test the applicant's fitness to practise medicine.

SECTION 8. Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches, or whoever practises medicine or surgery under a false or assumed name, or under a name other than that by which he is registered, or whoever personates another practitioner of a like or different name, shall, for each offence, be punished by a fine of not less than one hundred nor more than five hundred dollars, or by imprisonment for three months, or by both such fine and imprisonment. In a case in which a provision of this or the preceding section has been violated, the person who committed the violation shall not recover compensation for services rendered.

* Repealed by the Acts of 1902, and fixed salaries established.

SECTION 9. The provisions of the eight preceding sections shall not be held to discriminate against any particular school or system of medicine, to prohibit medical or surgical service in a case of emergency, or to prohibit the domestic administration of family remedies. They shall not apply to a commissioned medical officer of the United States army, navy or marine hospital service in the performance of his official duty; to a physician or surgeon from another state who is a legal practitioner in the state in which he resides, when in actual consultation with a legal practitioner of this commonwealth; to a physician or surgeon residing in another state and legally qualified to practise therein, whose general practice extends into the border towns of this commonwealth, if such physician does not open an office or designate a place in such towns where he may meet patients or receive calls; to a physician authorized to practise medicine in another state, when he is called as the family physician to attend a person temporarily abiding in this commonwealth; nor to registered pharmacists in prescribing gratuitously, osteopathists, pharmacists, clairvoyants, or persons practising hypnotism, magnetic healing, mind cure, massage, Christian science or cosmopathic method of healing, if they do not violate any of the provisions of section eight.

COMMONWEALTH *v.* ST. PIERRE.

This is a case in which a person in Fall River was accused of practising medicine without registration. His professional sign was that of an "eye specialist." He was sentenced in the municipal court to three months' imprisonment and to pay a fine of five hundred dollars, the maximum penalty. The case was carried to the superior court, where sentence was sustained; but certain exceptions were taken by the defendant's counsel to the rulings of the court. The exceptions were finally disposed of in the following opinion of the supreme judicial court, rendered on the thirteenth day of December, 1899: —

LORING, J. The exception to the exclusion of testimony offered by the defendant on cross-examination must be sustained. The government had introduced in evidence testimony of a number of persons to the effect that they had visited the defendant at various times; that he gave to them medicines, and advised them how to use them; that at these times they had conversations with him about the nature of their complaints; that he afterwards visited some of them at their houses and treated them there, and that they paid him money, and the bottles and packages, which the witnesses testified were given to them, had been put in evidence.

The defendant offered to prove that "each and every occasion at the time the parties were told by the defendant that he was not a doctor, and that he did not charge anything for his services." This evidence was excluded.

If the defendant sold the medicines, receiving payment therefor, and gave advice gratuitously as to the use to be made of them, he was not, so far as those instances were concerned, holding himself out as a physician; his declarations accompanying the acts and showing the character of them were admissible as part of the *res gestæ*.

Of course it was open to the government to contend that in these instances he was really acting as a physician, and was paid as such for his services, and that these statements were efforts to evade the statutory provisions here in question.

But when the Commonwealth put in testimony to the effect that he had given directions and advice as to the use of the contents of the packages and bottles sold by him, and had been paid by the persons to whom the contents were sold, it was the right of the defendant to prove that in each instance he was paid not for the advice but only for the drugs, and that he declared that he was not a physician; and in that way to raise the question whether, so far as these instances were concerned, he was selling the drugs and giving information gratuitously as to their use, and therefore not thereby holding himself out as a physician, or whether he was really acting as a physician, taking payment therefor, and was seeking by such declarations to evade the effect of his actions. This question was a question for the jury, under all circumstances, and the testimony offered should have been admitted.

As the questions involved in the other exceptions may arise in a new trial, they may be briefly disposed of here: —

2. The burden was on the defendant to show that he was a registered physician, if he relied on such a justification. Pub. Sts., c. 214, § 12. This applies to cases where the absence of a license is made part of a description of the offence. Commonwealth *v.* Kelly, 10 Cush. 69. Commonwealth *v.* Tuttle, 12 Cush. 502. Commonwealth *v.* Barnes, 138 Mass. 152. Commonwealth *v.* McCarthy, 141 Mass. 420.

3. Proof that the defendant acted either as a physician or surgeon was sufficient to support the complaint, which charged him with holding himself out as a physician and surgeon. There is but one offence, and that may be committed by the defendant's holding himself out as a physician or a surgeon; if the complaint charges that the offence is committed by the defendant's holding himself out both as a physician and surgeon, the whole offence is proved if he is shown to have held himself out as either. Commonwealth *v.* Dolan, 121 Mass. 374.

4. The ruling that, if the defendant held himself out as an eye specialist, he held himself out as "one who devoted himself to a branch of the healing art which is the profession of the physician and surgeon," and that "if the defendant held himself out as an eye specialist, he held himself out as a physician and surgeon within the meaning of the statute," was correct.

New trial ordered.

COMMONWEALTH *v.* MADDALINA DELLA-RUSSO.

The complaint against Della-Russo, a midwife, was that she held herself out as a practitioner of medicine; and that she practised medicine unlawfully. In the lower court, Suffolk County, William J. Forsaith, justice, she was adjudged guilty on both counts. An appeal was taken and the case was tried in the superior court, December term, 1904. Verdict, guilty on both counts. The contention of the defendant's counsel was that in holding herself out as a midwife she did not hold herself out as a practitioner of medicine, and that in her practice she attended only normal cases of labor, and in so doing she acted in the capacity of a nurse only.

Robert O. Harris, justice, charged the jury as follows: —

In the consideration of this case, it is well for the jury in the beginning to start upon their deliberations with a well-defined idea of what the issue is. This complaint charges the defendant in two counts: first, with holding herself out as a practitioner of medicine; second, as having practised medicine. The statute under which we are proceeding provides that, "Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches," shall be subject to a certain penalty. This statute, enacted in 1894, may be said to be a re-enactment, in a little different shape and with wider scope, of laws which had been on the statute books of this commonwealth for many years. Under the old law there arose the question which has been raised in this case as to whether it is necessary that a person should hold himself out to practise medicine generally in order to come within the purport of the statute. Under the early statute, in 1835, Chief Justice Shaw of the supreme court rendered an opinion as follows: —

> The first question for the court is whether, upon the facts agreed, the defendant can be held to be engaged in the practice of physic or surgery. It appears that he professes and practises bone setting and reducing sprains, swellings and contractions of the sinews, by friction and fomentations; but no other department of the curing art. By bone setting we understand the relief afforded as well in cases of dislocation as in those of fracture. The court are of the opinion that this brings him within the meaning of the statute as one who practises physic or surgery. We think it not necessary for one to profess to practise generally, either as a physician or surgeon, to bring him within the operation of this statute, but that it extends to any one engaging in practice in a distinct department of either profession, and that the defendant's practice forms a considerable department in the practice of surgery.*

That is to say, if one holds himself out to practise or practises in any line of endeavor which comes within the territory which belongs to medicine, he comes under this act, although he may follow a specialty.

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* Hewitt *v.* Charier, 16 Pickering, 353.

But this precise question as to whether midwifery is included within the statute has been directly decided in another Commonwealth, under a statute very similar in terms to ours. The case was a complaint against a woman for practising midwifery. The supreme court of that State said: —

> It appeared from the proof that the defendant held herself out as a midwife and practised in that capacity. It is urged this is not a violation of the act. We think very clearly it is. Midwifery is an important department of medicine, and is so recognized by the act. The law-making power of the State has enacted that "No person shall practise medicine in any of its departments in this state without the qualifications required by this act." The validity of such a law is not denied, but it is urged only that the defendant had not practised medicine within the meaning of the act. It needs no argument to show the importance of obstetrics as a department of medicine, nor the necessity that those who assume to practise in that department should possess due knowledge and skill. The welfare of their patients is certainly within the purview of the law, no less than in other departments, where, in many instances, at least, even less care and skill may be essential, and where the consequence of ignorance and unskillfulness may be less unfortunate.*

Under the rulings in these cases to which I have referred, and under the law as I understand it, I shall have to instruct you that as a matter of law one who undertakes to practise midwifery is one who is undertaking to practise medicine. The issue in this case is, therefore, whether this defendant has undertaken to practise as a midwife. If so, she is within the language of the act, because she has undertaken to practise medicine, or a branch thereof.

The question then in this case narrows itself down to just what this defendant did. She claims that she did not hold herself out to practise in any other way than as a mere nurse; and that she assumed no responsibilities in anything that she did in any case other than those of an ordinary trained or skilled nurse. And upon that issue you have to consider the evidence in the case. If all she did was to act simply as a nurse, acting under somebody else's directions and doing only those things which a mere nurse ordinarily does, and assuming no responsibility for anything excepting that she should do the things well as a nurse, then she is not guilty under this complaint. If, however, while calling herself a nurse she actually assumed the function of a physician, and advertised herself as being competent to perform the duties of an ordinary physician, and was engaged upon that understanding, then you will be warranted in finding her guilty.

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* People *v.* Arendt, 60 Ill. App. 89.

APPENDIX B.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE REGISTERED IN THE COMMONWEALTH TO THIS DATE, DEC. 31, 1904.

NOTE. — The following are the forms of certificates issued: —

Form A, to graduates of legally chartered medical colleges or universities having power to confer degrees in medicine, who applied for registration before the law went into full effect, on Jan. 1, 1895, graduation and residence in the Commonwealth at the time of the passage of the law being the only requirements for registration.

Form B, to those who applied for registration before Jan. 1, 1895, under the three years' practice clause in section 3 of chapter 458 of the Acts of 1894, three years' continuous practice in the Commonwealth next prior to the passage of the law June 7, 1894, being the only requirement for registration.

Form C, to graduates of legally chartered medical colleges in this Commonwealth who applied for registration subsequent to Jan. 1, 1895, and previous to May 1, 1896, during which period the law permitted their registration without an examination, a diploma from such sources being by the law considered satisfactory evidence of fitness to practise medicine. This provision of the law was repealed May 1, 1896.

Form D, to graduates examined by the Board.

Form E, to non-graduates examined by the Board.

Certificates D and E are the only forms issued since May 1, 1896.

Official List of Practitioners of Medicine.

A	Abbe, Alanson Joseph.
A	Abbe, Edward Hooper.
C	Abbe, Frederick Randolph.
A	Abbot, Edward Stanley.
D	Abbot, Florence Hale.
B	Abbott, Adelaide.
D	Abbott, Albert Francis.
A	Abbott, Charles Edward.
A	Abbott, Charles Shewell.
D	Abbott, Edson Moses.
D	Abbott, Eulalie Marie.
A	Abbott, Fred Lincoln.
A	Abbott, Frederick Wallace.
D	Abbott, Harry Daniel.
D	Abbott, Howard Edwin.
A	Abbott, Solon.
A	Abbott, Stephen Wendell.
B	Abbott, Sylvina Apphia.
D	Abel, William Clay.
A	Abell, Paul White.
D	Aberle, Lillie Anastasia.
A	Achorn, John Warren.
A	Acken, Thomas Moore.
D	Adam, John Geikie.
D	Adams, Carl Schadeker.
D	Adams, Charles Baker.
A	Adams, Charles Eli.
A	Adams, Charles Sumner.
A	Adams, Edward Hitchcock.
A	Adams, Edwin Boardman.
D	Adams, Eva Argene.
C	Adams, Francis Wayland.
A	Adams, George Edwin.
D	Adams, George Francis.
A	Adams, George Smith.
A	Adams, Herbert Williams.
A	Adams, James Forster Alleyne.
D	Adams, James Thacher.
D	Adams, John.
D	Adams, John Dresser.
A	Adams, John Quincy.
D	Adams, Walter Forester.
D	Adams, Walter Henry.
A	Adams, Wendell Holmes.
D	Adams, William Carlton.
D	Adams, William Gray.
D	Adams, Zabdiel Boylston.
A	Ahearne, Cornelius Augustine.
A	Ahearne, Cornelius Augustine, Jr.
D	Ahlquist, Ellen Maria.
A	Aiken, Frank Jonathan.
D	Aiken, Thomas Francis, Jr.
A	Ainsworth, Frank Henley.
A	Albee, George Macdonald.
A	Albee, George Sumner.
D	Alcorn, Thomas Grant.
D	Albro, Christopher Durfee.
D	Alden, Eliot.
B	Alden, Flora Sweet.
A	Aldrich, Albert Clinton.
A	Aldrich, Eben True.
A	Aldrich, James Mott.
A	Aldrich, Nathaniel Borden.
A	Alexander, Clara Jane.
D	Alexander, Thomas Branch.
D	Alfred, James.
A	Allard, Frank Ellsworth.
B	Allard, Joseph.
B	Allen, Alfred Morton.
A	Allen, Carl Addison.
D	Allen, Clarence Jean.
D	Allen, David Edmund.
D	Allen, Edward Everett.
A	Allen, Edwin Howard.
C	Allen, Frank Neute.
A	Allen, Franklin Haley.
D	Allen, Freeman.
A	Allen, Gardner Weld.
A	Allen, George Edwin.
A	Allen, Granville Stevens, Jr.
D	Allen, Horatio Cushing.
D	Allen, James Henry.
A	Allen, Justin.
A	Allen, Lamson.
A	Allen, Louis Edmund.
D	Allen, Lyman.
B	Allen, Nathan Leverett.
A	Allen, Samuel Johnson.
D	Allen, Seabury Wells.
A	Allen, Stephen Arthur.
A	Allen, William Howard.
E	Allendorff, John Aloysius.
D	Alley, Ernest Jason.
A	Allison, George Freeman.
D	Allison, Nathaniel.
D	Amadon, Alfred Mason.
A	Amadon, Arthur Frank.
D	Ameno, Joseph Louis.
A	Amerige, Charles Wardwell.
A	Ames, Charles Edwin.
A	Ames, John Lincoln.
A	Ames, Robert Parker Marr.
D	Ames, Winfield Howard.
A	Amesbury, Ivon Cuthbert Raleigh.
A	Amesbury, Water Raleigh.
A	Amory, Robert.
D	Amrock, John Henry.
D	Amsden, Henry Hubbard.
D	Anderson, Hyrum Andrew.
D	Anderson, John Hammond.
A	Anderson, Martha Ann.
D	Anderson, Robert Harcourt.
D	Anderson, Thomas.
D	Andrews, Alfred Ross.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Andrews, Brainard Alge.
D	Andrews, Edward Austin.
D	Andrews, Harold Virgil.
D	Andrews, John Henry.
A	Andrews, Mary Annette.
D	Andrews, Oren.
D	Andrews, Robert Eaton.
D	Andrews, Robert Foster.
A	Angell, Henry Clay.
D	Angeny, Granville Louis.
A	Anthony, Francis Wayland.
A	Anthony, Jeremiah Christopher.
A	Appleton, Lucy.
C	Appleton, William.
D	Archambault, Jean Baptiste.
D	Archambault, Joseph Arthur.
A	Archambeault, Charles Francis.
D	Archibald, Harry Nelson.
E	Arkin, Louis.
D	Armington, Herbert Hamlin.
D	Armstrong, William Lucius.
D	Armstrong, William Willard.
A	Arnold, Horace David.
A	Aronowitsch, Anna.
B	Aronson, Harris.
A	Arthur, Asa Adgate.
E	Ascher, Joseph.
C	Ash, John Henry.
D	Ash, Thomas Francis.
D	Ashley, Edward Fiske.
D	Aspray, Joseph.
D	Atkins, Francis Grant.
D	Atkins, Grace Elizabeth.
C	Atkinson, Leonard Woods.
A	Atkinson, Lizzie Daniel Rose.
D	Atkinson, Roger Trowbridge.
A	Atwater, James Billings.
A	Atwood, Albert John.
D	Atwood, Abel Wilson.
A	Atwood, Charles Augustus.
D	Atwood, Charles Fenner.
A	Atwood, Frank Sumner.
A	Atwood, George Manley.
A	Auger, Adolphe Alphonse.
A	Auger, Henri Michel.
A	Auger, Louis Lemaitre.
A	August, Albert.
D	Aursleff, Carl.
A	Austin, Arthur Everett.
B	Austin, Charles Gorham Stubbs.
D	Austin, James Cornelius.
A	Austin, Lewis King.
D	Austin, Mabel Fletcher.
D	Avedisian, Avedis Der.
D	Averell, Charles Wilson.
C	Averill, George Goodwin.
A	Averill, Jesse Howes.
B	Averill, Mehitable Merrill.
D	Avery, John Waite.
A	Ayer, James Bourne.
A	Ayer, Silas Hubbard.
D	Ayer, Thomas Herbert.
E	Ayres, Harold Winslow.
D	Babbitt, Charles Holton.
A	Babbitt, Henry Bradford.
A	Babbitt, Warren Morris.
A	Babcock, Daniel Arnold.
D	Babcock, Elisha Franklin.
A	Babcock, Francis Lester.
D	Bachand, Joseph.
B	Bacon, Grenville.
D	Bacon, John Lowell, Jr.
A	Bacon, Jonas Edward.
A	Bacon, Joseph Ambrose Patrick.
E	Bacon, Newton Samuel.
D	Bacon, Theodore Spaulding.
D	Badanes, Ida.
D	Badger, Fremont Dayton.
B	Badger, George Augustus.
D	Badger, George Sherwin Clarke.
D	Baff, Max.
E	Bail, John Warren.
A	Bailey, Charles.
A	Bailey, Charles Hardy.
D	Bailey, Ernest Harry.
D	Bailey, Florence.
D	Bailey, Frederick James.
A	Bailey, George Guy.
B	Bailey, George Henry.
E	Bailey, George Samuel.
B	Bailey, Henry Plummer.
D	Bailey, Marshall Henry.
A	Bailey, Stephen Goodhue.
D	Bailey, Walter Channing, Jr.
A	Bailey, William Henry.
B	Bailey, William Howard.
D	Bailey, William Thomas.
D	Bain, John Baxter.
A	Baird, Julian William.
A	Baird, William Perry.
D	Baker, Albert Sherburne.
D	Baker, Benjamin Ward.
D	Baker, Chester Monroe.
A	Baker, Flint Almena Jane.
A	Baker, David Erastus.
A	Baker, Frank.
A	Baker, Frederick Herbert.
D	Baker, George Lorimer.
A	Baker, Harry Beecher.
D	Baker, Ida Belle.
A	Baker, Jane Rogers.
B	Baker, Joseph Calbeck.
A	Baker, Leland Madden.
D	Baker, Lewis Forrester.
E	Baker, Lily Owen.
D	Baker, Osmyn.
A	Baker, William Henry.
D	Baketel, Roy Vincent.
D	Balboni, Gerardo Monari.
D	Balch, Alfred William.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Balch, Franklin Greene.
D	Balcom, Elmer Irving.
A	Balcom, George Franklin.
C	Balcom, John Alvin.
A	Balcom, Lafayette.
A	Baldwin, Frederick William.
D	Baldwin, Harrison Peck.
A	Baldwin, Henry Cutler.
C	Baldwin, Herman Trost.
D	Baldwin, Sanford Oscar.
D	Ball, Clarence Franklin.
A	Ball, Thomas Joseph.
A	Ballance, William Pell.
D	Ballantyne, Charles Thomas.
A	Ballard, George Tyler.
B	Ballou, Henry Edmund.
E	Balmer, William Edward.
E	Bamji, Manak.
A	Bancroft, Edward Erastus.
A	Bancroft, George Andrew.
E	Bancroft, Irving Reed.
A	Bancroft, Winfred Baxter.
D	Bandiera, John.
A	Banfield, Francis Loring.
A	Bangs, Charles Howard.
D	Bannerman, Walter Bruce.
A	Bannon, Bernard James.
D	Bannon, John Hugh.
A	Barbrick, John Fraser.
D	Bardwell, Frederick Albert.
A	Baribault, William Alfred.
D	Baright, Herbert Edwin.
A	Barker, Emilie Jones.
A	Barker, Frank Justin.
D	Barker, Ruth.
D	Barlow, Myron.
D	Barnard, Belle Strickland.
A	Barnard, Rebecca.
A	Barnaud, Elie.
D	Barnes, Allan Foster.
E	Barnes, Charles Hall.
D	Barnes, George.
A	Barnes, Francis Henry.
A	Barnes, Francis John.
D	Barnes, Harry Aldrich.
D	Barnes, Harry Lee.
D	Barnes, Henry.
A	Barnes, Henry Jabez.
A	Barnes, Ida Florence.
E	Barnes, James Arthur.
D	Barnes, Lynn Moore.
A	Barnes, William Ellsworth.
D	Barney, Charles Norton.
D	Barney, James Dellinger.
A	Barney-Hall, Lucy Robinson.
D	Barraclough, Alfred Whitley.
A	Barré, Joseph Aladin.
E	Barrell, Charles Sewell.
A	Barrell, George Morton.
D	Barrell, Mary Elizabeth.

D	Barrett, Edward William.
E	Barrett, Joel Lewis.
D	Barrett, Michael Francis.
D	Barrett, Richard Francis.
A	Barrett, William Marshall.
A	Barrows, William Ezra.
D	Barry, Emmet William.
D	Barry, James Henry.
E	Barry, Joanna.
D	Barry, John Aloysius.
B	Barry, William Copinger.
A	Barstow, Henry Taylor.
D	Bartlett, Charles Watson.
D	Bartlett, Clarence Samuel.
D	Bartlett, Daniel Edwin.
A	Bartlett, Frederic Russell.
A	Bartlett, Oliver Leslie.
D	Bartlett, Percy.
D	Bartlett, Philip Challis.
D	Bartlett, Robert Lander.
E	Bartlett, Samuel Danforth.
A	Bartlett, Solon.
D	Bartlett, Walter Oscar.
D	Bartley, John Joseph.
A	Bartol, John Washburn.
D	Bartol, Edward Francis Washburn.
A	Barton, Charles Herbert.
A	Barton, Chester Manley.
A	Barton, Jedediah Marcus.
D	Barton, John Alfred.
D	Barton, Walter Emery.
B	Basford, James Lendale.
A	Bass, William.
D	Bassett, Alice Haley.
A	Bassett, Elton James.
D	Bassow, George Joseph.
D	Bastian, George Leon.
A	Batchelder, Frederick Prescott.
A	Batchelder, John Couch.
A	Batchelder, Mary Ann.
A	Batchelder, William Burdett.
A	Bateman, Frank Elliot.
D	Bates, Charles Atwood.
A	Bates, Everett Alanson.
C	Bates, Mary Elizabeth.
D	Bates, Walter Simpson.
D	Bates, Willard Asa.
A	Battershall, Joseph Ward.
A	Battershall, Mary Hannah Wolfenden.
A	Baxter, Edward Hooker.
A	Baxter, John.
D	Baxter, William Elihu.
D	Bayliss, Andrew.
A	Baynum, Mary Herrick.
A	Bazin, Adelard.
A	Beach, Henry Harris Aubrey.
D	Beal, Herman Alaric.
D	Beal, Howard Walter.
D	Beale, Samuel Marsden, Jr.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Beals, Arthur Loring.
A	Bean, Charles Pierce.
A	Bean, George Henry.
A	Bean, Jacob Walter.
A	Beane, Newell Wesley.
D	Beaton, Alexander Angus.
D	Beaton, Archibald Edward.
D	Beattie, John.
D	Beattie, Robert Fowler.
A	Beatty, Franklin Thomason.
A	Beauchamp, Aimé.
A	Beauchamp, Joseph Octave.
A	Beauchamp, Zenophide.
D	Beaulieu, Francis Xavier.
A	Beaudet, Napoleon.
D	Beauparlant, Joseph David.
D	Beckett, Frank Henry.
D	Beckley, Chester Charles.
D	Beckner, Clara Lee.
A	Bedard, Joseph Armand.
E	Beddall, Albert Richard.
D	Beddell, Charles Ellsworth.
A	Beebe, George Hatch.
A	Beebe, John Belcher.
A	Beebe, Richard.
D	Beebe, Theodore Chapin, Jr.
D	Beecher, Clarence Henry.
B	Beecher, John Asbury.
D	Beede, M. Josephine.
E	Beering, Frederick William, Jr.
D	Beharrell, Sarah Elizabeth.
A	Beland, Henry Severin.
A	Belanger, David Simeon.
D	Belden, Albert Matson.
E	Belding, John Eastman.
D	Belknap, James Lyman.
B	Bell, Christina Eunice Crawford.
D	Bell, Clarence John.
A	Bell, George Parson.
A	Bell, Homer Simpson.
A	Bell, James Bachelder.
D	Bell, Robert Eddy.
A	Bell, William Appleton.
D	Bellamy, William Woolsey.
D	Bellehumeur, Stanislas David.
A	Bellows, Howard Perry.
A	Bemis, Charles Albert.
A	Bemis, Charles Vose.
A	Bemis, John Merrick.
A	Bemis, Merrick.
E	Bemis, Oscar Adelbert.
D	Bender, Prosper.
D	Benjamin, Walter Robinson.
A	Benner, Burnham Roswell.
D	Benner, Herbert Orray.
D	Benner, Richard Stanwood.
D	Bennett, Alice.
D	Bennett, Ernest Walsworth.
A	Bennett, Frederick Sherwin.
A	Bennett, John Hilman.
A	Bennett, William Henry.
D	Bennett, William Hurlburt.
A	Bennitt, Francis Marion.
A	Benoit, Benjamin.
A	Benoit, Louis Raymond.
D	Benson, Charles Sweetser.
A	Bent, Gilbert Wesley Warren.
D	Berard, Albert Joseph.
D	Berg, Tekla Amalia Josefina.
E	Bergengren, Charles Henry.
B	Bergengren, Frederick Wilhelm Alexis.
A	Bergeron, Francois de Borgia.
D	Bergeron, Pierre Norbert.
A	Bergeron, Seraphin Ensèbe.
D	Bergeson, John.
D	Bergin, Stephen Albert.
D	Bergwall, Walter.
B	Berkman, David Wulf.
D	Berlin, Fanny.
A	Bernard, Barnard Lecherzack.
D	Bernard, Flocker.
D	Bernauer, Emil Constantine.
E	Bernier, Joseph Adolphe.
E	Berry, Charles Francis.
D	Berry, John Cutting.
A	Berry, Lauriston.
D	Berry, Nathaniel Leander, Jr.
D	Berry, Walter Durant.
A	Bertram, William Henry.
D	Bertrand, Alexis Evariste.
D	Berwick, James Roderick.
A	Best, Enoch George.
A	Bethune, Donald John.
A	Betts, Helen Loretta.
D	Bianco, Joseph Anthony.
D	Bicknell, George Cleveland.
D	Bicknell, Ralph Emerson.
E	Bicknell, William Horace.
E	Biello, Joseph Albert.
D	Bigelow, Alfred Mahlon.
A	Bigelow, Charles Edwin.
D	Bigelow, Edward Bridge.
A	Bigelow, Enos Hoyt.
A	Bigelow, William Sturgis.
A	Bill, Harriet Parmenter.
A	Billings, William Chester.
A	Bilodeau, Wencelas.
E	Binford, Ferdinand Augustus.
B	Bingham, Edna Melvia.
D	Bingham, Russell.
D	Binney, Horace.
B	Birch, Sylvanus Jutkins.
D	Birchard, George Grant.
A	Birdseye, Frederick Gould.
A	Birge, Ella Freeman.
A	Birge, William Spafard.
B	Birmingham, Lewis Haydn.
D	Birmingham, Louis Howland.
A	Birmingham, Robert Michael.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Biron, Joseph Frederic Rodolphe.
D Biron, Wilfrid Louis.
A Birtwell, Charles Ebenezer.
D Bishop, Franklin Lee.
B Bishop, Henry Earl.
B Bishop, Jane Emma.
D Bixby, Ernest Pierre.
A Bixby, Josiah Peet.
D Black, George Luke.
E Black, James Stanislaus.
D Black, Jotham Freathy.
A Blackmer, John.
E Blackmore, Richard, Jr.
A Blackwood-Chamberlain, Ellen Ramsdell.
D Blaine, Walter Edward.
A Blair, Arthur Walter.
D Blair, George Kenniston.
A Blair, James Franklin.
A Blair, John.
D Blair, Orland Rossini.
D Blair, Orrin Curtis.
D Blair, William Franklin.
A Blais, Pierre Gaspard.
A Blaisdell, George Warren.
A Blaisdell, James Edward.
A Blaisdell, Walter Channing.
D Blake, Allen Hanson.
A Blake, Charles Abbott.
A Blake, Clarence John.
A Blake, Harrison Gray.
E Blake, James Henry.
A Blake, John Bapst.
A Blake, John George.
A Blake, Le Grand.
B Blake, Mary Jane.
A Blake, Warren Perkins.
D Blakely, David Newton.
A Blanchard, Albert Henry.
A Blanchard, Benjamin Seaver.
D Blanchard, Randall Howard.
E Blanchard, Stanley Wayne.
A Blanchard, Walter Irving.
A Blanchette, Alexander.
D Blanchette, William Henry.
D Blaney, Cyril Arthur.
D Blenkhorn, James.
A Bliss, George Danforth.
D Bliss, George Stephen.
D Bliss, Jesse Leonti.
A Bliss, Wilbur Howard.
A Blodgett, Albert George.
A Blodgett, Albert Novatus.
D Blodgett, Harry Percival.
D Blodgett, John Hammond.
D Blodgett, John Henry.
A Blodgett, Stephen Haskell.
D Blodgett, William Ernest.
A Blood, Robert Allen.
D Bloom, David Nathan.
A Blossom, Anne Mooers.
D Boardman, Albertus Kellogg.
A Boardman, William Elbridge.
A Boardman, William Sydney.
E Bodfish, Gertrude Trevette.
D Bohemier, Joseph Eugene Napoleon.
A Boland, Elisha Shepherd.
D Bolles, Celia June.
A Bolles, William Palmer
D Bolster, Augustus Sargent.
A Bolton, Charles James.
D Bolton, William Jackson.
D Bommarito, Paolo.
A Bond, Aaron John.
A Bond, Sarah Adams.
E Bond, Walter Legrand.
A Bond, Willis George.
A Bongartz, Walter Eugene.
D Bonnar, James Miller.
D Bonnell, Clarence Hornbeek.
E Bonneville, Alfred Joseph.
D Bonney, Charles Austin, Jr.
A Bonney, Franklin.
D Bonney, Robert.
D Bonoff, Zelly Adam.
C Bonyman, Harry Evan.
D Boodro, William Henry.
A Boody, Charles Hayes.
D Boomhower, Alberta Sylvia.
D Boos, William Frederick.
A Booth, Anthony Francis.
C Booth, Edward Chauncey.
A Booth, Robert.
A Boom, Augustus Keefer.
D Borden, Charles Richardson Cobb.
A Borden, Henry Francis.
A Bossidy, John Collins.
A Bosworth, John William.
A Bothfeld, James Francis.
A Bottomley, John Taylor.
A Boucher, George Alphonse.
A Boucher, Joseph Adelard.
A Bough, Irvin Gustavus.
E Bouin, Charles.
A Boulay, Josephus Charles.
A Bourbonnais, Hermanglide.
D Boutelle, Harry Clifton.
D Bowen, Enos Emanuel.
D Bowditch, Henry Ingersoll.
A Bowditch, Vincent Yardley.
E Bowen, Alfred Preston.
D Bowen, Arthur Hosmer.
E Bowen, Fred J.
A Bowen, John Templeton.
A Bowen, Merritt Alphonso.
A Bowen, Seabury Warren.
D Bowers, Elbern Taylor.
A Bowers, Walter Prentice.
A Bowker, Alphonso Varion.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Bowker, Charles.
C	Bowker, Everett M.
B	Bowker, Horace Leander.
A	Bowker, John Copps.
B	Bowker, Samuel Dawes.
A	Bowles, George Hall.
A	Bowles, Stephen Wallace.
E	Bowman, Alfred Winthrop.
D	Bowman, Anthony William.
A	Bowman, Fred Raymond.
C	Bowman, Winthrop Height.
A	Boyd, Herbert Drummond.
D	Boyd, James Van Wagner.
D	Boyce, Alvin.
B	Boyer, Joel.
D	Boyer, Joseph Napoleon.
D	Boylan, Thomas Edward.
C	Boyle, Alfred John.
D	Boyle, Frank Meagher.
D	Boyle, John Francis.
D	Boyle, Thomas Patrick.
B	Boynton, Edwin Moses.
E	Boynton, Henry Bullard.
E	Boynton, Roy John.
B	Boynton, Stella.
A	Brace, George Welles.
A	Brackett, Elizabeth Annastatia.
A	Brackett, Elliott Gray.
A	Brackett, Humphrey Fall.
A	Bradbury, Charles Huntress.
A	Bradford, Cary Carpenter.
A	Bradford, Edward Hickling.
A	Bradford, Henry Withington.
A	Bradford, Oliver Leach.
A	Bradley, Charles How.
A	Bradley, Charles Seymour.
A	Bradley, Hannah Laura.
D	Brady, Frank Robert.
D	Brady, Frederic Le Brun.
D	Brady, James Francis.
A	Bragdon, George Albert.
C	Bragdon, Horace Elwood.
A	Bragg, Francis Adelbert.
D	Bragg, Leslie Raymond.
A	Brainerd, John Bliss.
D	Brainerd, Walter Scott.
A	Braird, William Henry.
A	Braley, Henry Hudson.
D	Branch, Charles Franklin.
B	Brande, Charles Drake.
A	Brandt, William Eugene.
A	Branscomb, William Gower.
A	Bray, Amanda Currier.
A	Bray, Edward Van Deusen.
D	Brayton, Roland Walker.
A	Breck, Samuel.
E	Breed, Nathaniel Perkins.
D	Breed, Nathaniel Pope.
D	Breitling, Joseph Cushman.
D	Bremer, John Lewis.
A	Brennan, John Joseph.
E	Brennan, Joseph Thomas Louis.
D	Brennan, Thomas Joseph.
A	Bresenham, Charles Wilson.
B	Breton, Joseph Henry.
D	Brett, Edward Joseph.
A	Brett, Frank Wallace.
A	Brewster, George Washington Wales.
A	Brewster, James Bartlett.
A	Brewster, Mary Jones.
A	Brick, Francis.
D	Brickett, Beatrice Hannah.
D	Bridge, Emma Frances.
A	Bridgham, Charles Burr.
D	Bridgham, Samuel Crosby.
D	Bridgman, Burt Nichols.
D	Briggs, Albert Simmons.
A	Briggs, Charles Albert.
D	Briggs, Charles Edwin.
A	Briggs, Charles Poor.
A	Briggs, Clifton Dean.
A	Briggs, Edward Cornelius.
D	Briggs, Elizabeth May Richardson.
A	Briggs, Frederic Melancthon.
B	Briggs, James Henry.
A	Briggs, Joseph Emmons.
D	Briggs, Lloyd Vernon.
D	Briggs, Merton Lawrence.
D	Brigham, Clarence Sumner.
A	Brigham, Edwin Howard.
D	Brigham, Fred Clayton.
A	Brigham, Hubbard Hammond.
D	Brigham, Percy Herbert.
D	Brightman, Helen.
A	Brimmer, Ida Lucinda.
D	Brindamour, Joseph Edmond.
A	Brindisi, Rocco.
A	Brissett, Henry Rupert.
E	Broadbridge, Harry Norman.
A	Brock, Charles Fremont.
E	Brock, Laurence Ambrose.
A	Brockway, Charles Henry.
D	Broderick, Frank Patrick.
A	Broderick, Thomas Joseph.
D	Broga, William Wallace.
A	Broidrick, James Patrick.
D	Brooks, Edith May.
B	Brooks, George Frederick.
D	Brooks, Helen Elizabeth.
D	Brooks, Ida Joe.
A	Brooks, James Fenner.
D	Brooks, John Eugene.
A	Brooks, Lawton Stickney.
A	Brooks, Samuel Doolittle.
D	Brooks, Simon Pomeroy.
A	Brooks, William Allen, Jr.
D	Brosseau, Wilfrid Arthur.
A	Brough, David Dandie.
A	Brough, Frank Thomson.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Broughton, Arthur Nicholson.
A Broughton, Henry White.
D Brousseau, William Gilbert.
A Brown, Alden Woodbridge.
D Brown, Alphonso Bickford.
A Brown, Anthony Leopold.
A Brown, Charles Robinson.
E Brown, Dale Edward.
A Brown, Daniel Eugene.
A Brown, Daniel Joseph.
D Brown, Daniel Rollins.
D Brown, Edward Manning.
D Brown, Edward Wells.
A Brown, Edwin Coleman.
A Brown, Electa Ann.
B Brown, Eugene Merchants.
A Brown, Francis Henry.
A Brown, Frank Byron.
A Brown, Frederick Augustus.
A Brown, George Artemas.
D Brown, George Christopher.
D Brown, Harry Albertus.
A Brown, Henry Rienzi.
D Brown, Henry Rolf.
A Brown, Henry Wilson.
D Brown, Hubert Leslie.
B Brown, Jacob Wales.
A Brown, John Peaslee.
D Brown, Luther Ainslee.
A Brown, Marshall Lebanon.
A Brown, Martin Millard.
D Brown, Melvin James.
D Brown, Olive Winona.
A Brown, Orestes Morton.
A Brown, Orland Jonas.
D Brown, Percy Emerson.
D Brown, Phœbe Day.
A Brown, Plumb, Jr.
A Brown, Roscoe Ellsworth.
A Brown, Wallace Everett.
A Brown, Wilfred Gardner.
B Brown, William Edward.
B Brown, William Francis.
D Brown, William John.
B Brown, William Ronald.
A Brown, William Symington.
A Brown, Windsor Aldrich.
D Browne, John George.
A Browne, Percy Gilbert.
A Browne, Proctor Kinsman.
A Browne, Will Warpool.
A Brownell, De Ette.
D Brownrigg, Albert Edward.
A Brownrigg, John Sylvester.
D Bruce, Charles Wesley.
A Bruce, Daniel Angus.
A Bruce, Emily Allen.
A Bruce, Frank Colverd.
A Bruce, John Angus.
D Brunelle, Pierre.
D Brunet, Michel.
D Brush, Frederic Louis.
A Bryant, Alice Gertrude.
A Bryant, Anna Mary Dorr.
D Bryant, Charles Henry.
D Bryant, Charles Sawyer.
A Bryant, Edward Gilman.
D Bryant, Fred.
A Bryant, Giles Waite.
A Bryant, John.
D Bryant, John Edmund.
A Bryant, Lewis Lincoln.
A Bryant, Virginia Frances.
A Bryant, William Sohier.
D Bryer, James Allen.
A Bryson, Adelbert Allen.
D Buccieri, Mario.
D Buchanan, Charles Stephen.
A Buck, Augustus Walter.
D Buck, Charles Edward.
A Buck, Charles John.
D Buck, Edward Terry.
C Buck, Howard Mendenhall.
D Buck, Maurice Allon.
A Buckingham, Edward Marshall.
D Buckley, Daniel Joseph.
D Buckley, James Thomas.
A Buckley, John Francis.
A Buckley, Philip Townsend.
D Buckley, William Stephen.
D Buehler, George Van Buskirk.
E Bufford, John Henry.
D Buffum, Herbert Edwin.
D Buffum, William Henry.
D Bugbee, Marion Louise.
D Buhrman, Ettie Ray.
A Bulfinch, George Greenleaf.
E Bulkeley, Frank Stedman.
A Bullard, George Eli.
A Bullard, Herbert Cutler.
C Bullard, John Thornton.
A Bullard, William Norton.
C Bullock, Edwin Warren.
A Bullock, George Dexter.
D Bump, Lewis Nye.
A Bundy, Frank Eastman.
D Bunn, Frank Caulkins.
C Burchmore, Charles Francis Preston.
E Burden, Ernest Druecilla.
A Burge, William Prentice.
B Burgess, Albert Lindsey.
D Burgess, Charles James.
A Burgess, Oliver Graham.
D Burgess, Sherman William.
D Burke, Francis Ramon.
A Burke, James Joseph.
D Burke, Michael Francis.
D Burke, Walter Thomas.
A Burke, William George.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Burke, William Henry.
A	Burleigh, Charles.
A	Burleigh, Frederick Wing.
D	Burleigh, Robert Fletcher.
D	Burley, Benjamin Thomas.
D	Burnell, Charles Willard.
A	Burnett, Frank George.
A	Burnett, Frank Hollis.
A	Burnett, Fred Nelson.
A	Burnett, Theodore Crètè.
D	Burnett, William Walton.
D	Burnette, John Everett.
A	Burnham, Elmond Arthur.
D	Burnham, Frederick Gray.
D	Burnham, Joseph Forrest.
D	Burnham, Melvin Page.
D	Burnham, Parker.
D	Burns, Frederick Stanford.
A	Burns, Hiram Hutchins.
D	Burns, Robert.
E	Burns, Walter Linn.
D	Burpee, Carroll Colby.
D	Burque, Joseph George.
A	Burr, Charles Henry.
D	Burr, Noah Arthur.
A	Burrage, Walter Lincoln.
A	Burrell, Benjamin Henry.
A	Burrell, Herbert Leslie.
D	Burroughs, Amelia.
D	Burt, Charles Kellogg.
D	Burt, Edward Walter.
A	Burt, Frank Leslie.
A	Burtch, Harry Mercein.
A	Burton, Charles William.
D	Burton, James.
A	Burton, Stephen Caspar.
D	Bush, Arthur Dermont.
D	Bush, Charles William.
A	Bush, John Standish Foster.
C	Bushee, James Anson.
D	Bushnell, Edward Henry.
A	Bushnell, Homer.
D	Bushold, Fred George.
D	Buswell, Albert Currier.
B	Buswell, Arthur True.
D	Butler, Benjamin Joseph.
E	Butler, Charles Shorey.
D	Butler, David Presbury, Jr.
D	Butler, George Edward.
A	Butler, John Edward.
D	Butler, Lester Emmons.
D	Butler, Patrick Francis.
D	Butler, Richard Bernard.
D	Butler, Rodman.
D	Butler, Samuel.
A	Butler, Winthrop.
D	Butler, William Hodnett.
D	Buttler, Charles Voorhees.
B	Butman, William Aaron.
A	Butterfield, George Washington.
C	Butterworth, Mary Frances.
A	Buzzell, Daniel Thompson.
A	Bychower, Victor.
D	Byers, David Walter.
D	Byrne, Charles Armstrong.
D	Byrnes, Harry Francis.
A	Cabana, Louis Victor.
A	Cabot, Arthur Tracy.
D	Cabot, Hugh.
A	Cabot, Richard Clark.
D	Cadigan, John Joseph.
A	Cahill, Charles Sumner.
A	Cahill, Eliza Buckman.
A	Cahill, George Stephen.
E	Cahill, John Thomas.
A	Caiger, Albert Edward.
C	Cain, Henry Walter.
E	Cain, Maude Florence.
A	Cain, Willie George.
E	Caisse, George Emile.
D	Caithness, George Eager.
A	Calder, James Squair.
D	Calderwood, Edward Swazey.
A	Calderwood, Samuel Herbert.
D	Caldwell, Albert Francis, Jr.
C	Caldwell, George Peters.
A	Calkins, Barry Howes.
A	Calkins, Cheney Hosmer.
D	Calkins, Irving Romaro.
A	Calkins, Marshall.
A	Call, Emma Louisa.
D	Callahan, Joseph Thomas.
A	Callanan, Sampson Aloysius.
A	Callender, Charles Harlow.
D	Calnane, John Andrew.
D	Cameron, Charles Ernest.
A	Cameron, Ewan.
C	Camfill, Robert Emmet.
A	Camp, Charles Welford.
A	Camp, Mary Augusta.
D	Campbell, Annie Butterfield.
C	Campbell, Benjamin Franklin.
D	Campbell, Franklin Edward.
A	Campbell, Fidelia Green.
B	Campbell, James Parker.
D	Campbell, Kleber Alexander.
D	Campbell, Matthew Philip.
A	Campbell, Patrick Henry.
E	Campbell, Sheldon Samuel Stratton.
D	Cane, Francis Edward.
D	Canedy, Charles Francis.
A	Canedy, Francis Joel.
A	Canedy, Fred Snow.
D	Canedy, Ransford De Los.
D	Canfield, Roy Bishop.
D	Canney, Ellen Rose.
B	Canning, John Francis.
A	Cannon, David Howland.
D	Capelle, Charles Stanislaus.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Capen, Elwyn Winslow.
A	Capen, Samuel Ross.
A	Capen, Thomas Allyn.
D	Capps, Joseph Almarin.
D	Carbone, Giovanni.
A	Card, Frank Edwin.
D	Card, Horatio Smith.
E	Carden, Charles James.
D	Carl, Bertha Frederica.
D	Carl, Isaac Daniel.
C	Carleton, Dudley.
A	Carleton, Francis Boyd.
A	Carleton, Ralph.
A	Carleton, Charles Greenleaf.
A	Carleton, Charles Horace.
A	Carleton, Elizabeth Abbott.
D	Carlisle, Frank Henry.
C	Carlton, Mary Elizabeth.
A	Carmichael, John Hosea.
E	Carmody, William Francis.
A	Carolin, William Terence.
D	Caron, Amable Berthelat.
D	Carothers, William Harsha.
A	Carpenter, Edward Annon.
B	Carpenter, George Clifton.
A	Carpenter, Helen Braddock.
B	Carpenter, Julia May.
B	Carpenter, Mary Adelaide.
B	Carpenter, Sylvester Stiles.
A	Carpenter, William Henry.
D	Carr, Christopher James.
D	Carr, Bernard Joseph.
A	Carr, Frank Fletcher.
D	Carr, George Byron.
A	Carr, Lucy Stearns.
E	Carr, Percy Whitman.
D	Carr, Ralph Stanfield.
B	Carroll, Elizabeth Minnette.
A	Carroll, Francis Edward.
A	Carroll, John Aloysius.
D	Carroll, John Philip.
A	Carroll, Thomas Francis.
D	Carroll, Thomas Francis.
A	Carroll, William Edward.
A	Carruth, Sidney Stetson.
D	Carsley, Sidney Raymond.
A	Carson, Paul.
E	Carter, Curtis Sumner.
A	Carter, Frank Henry.
A	Carter, Robert Lindsey.
C	Carter, Theron Harlow.
B	Carver, Ichabod.
A	Carvill, Alphonso Holland.
D	Cary, Foster Harrington.
D	Casgrain, Charles Arthur.
D	Casselbury, Clarence Marmaduke.
E	Cassidy, James Joseph.
D	Cassinikos, Panagiotes.
D	Castillo, Frank Martin del.
D	Castle, Catharine White.
D	Castle, Edward Beardslee.
A	Castle, James.
D	Caswell, Bertram Horace.
D	Cate, Frederick Symon.
A	Cate, George Riley.
F	Cate, Shadrack Mellen.
D	Caulfield, George Beresford.
E	Caulfield, Thomas Edward.
C	Cavanagh, Charles Russell.
A	Cavanagh, Walter James.
D	Cavanaugh, Loretta Katherine.
D	Cavanaugh, Mortimer Thomas.
D	Cavanaugh, Thomas Edward.
D	Caverly, Charles Frank, Jr.
D	Cawley, Ernest Guy.
D	Ceconi, John Aloysius.
A	Celce, Frank Frederick.
A	Celce, Jean Henriette.
D	Chace, Ann H.
D	Chace, Arthur Freeborn.
D	Chace, Eleanor Sarah.
A	Chadbourne, Arthur Patterson.
D	Chadwell, Orville Rogers.
C	Chadwick, Henry Dexter.
A	Chadwick, James Read.
D	Chaffers, Joseph.
A	Chagnon, Charles Emile.
A	Chagnon, Joseph Samuel.
D	Chagnon, Tancrède Deodatus.
A	Chagnon, Winceslas John Baptiste.
A	Chalifaux, Joseph Herménégilde.
A	Chalmers, Robert.
A	Chamberlain, George Felton.
D	Chamberlain, George Elliott.
A	Chamberlain, George Washington.
A	Chamberlain, Myron Leon.
A	Chamberlain, William Eugene.
A	Chamberlin, Edward Henry.
B	Chamberlin, James Prescott.
D	Chamberlin, Theodore.
A	Champlin, Martha Godfrey.
A	Chandler, Henry Beckles.
B	Chandler, Ira.
A	Chandler, Luther Graves.
A	Chandler, Norman Fitch.
D	Chandler, Thomas Evans.
A	Channing, Walter.
D	Chapin, Alva Le Roy.
D	Chapin, Clifford Samuel.
A	Chapin, Della Lucretia.
A	Chapin, Frederic Wilcox.
A	Chapin, Walter Henry.
A	Chapman, Charles Ratchford.
D	Chapman, Howard Jones.
D	Chapman, William Lewis.
D	Chaput, Henry Ernest.
A	Charbonneau, Joseph.
D	Charbonneau, Noe Napoleon.
A	Charbonneau, Oliver.
A	Charles, Orlando Warrington.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Charron, Joseph Rosario.
D Charteris, Mary Alena.
A Chase, Arthur Brown.
A Chase, Augustus Lucius.
C Chase, Charles Tristram.
D Chase, Daniel Emery, Jr.
A Chase, DeForest Woodruff.
D Chase, Edwin Llewellyn.
A Chase, Eli Ayer.
D Chase, Frank Hills.
D Chase, Henry Melville.
A Chase, Heman Lincoln.
A Chase, Herbert Augustus.
A Chase, Hiram Luce.
A Chase, Horace.
A Chase, Irah Eaton.
D Chase, James Smalley.
A Chase, John Winslow.
A Chase, Joseph, Jr.
D Chase, Lawrence Milton.
A Chase, Richard Fitch.
D Chase, Walter Greenough.
A Chase, William Bradley.
D Chaussé, Joseph Arthur.
A Cheever, Clarence Alonzo.
D Cheever, David.
A Cheever, David Williams.
D Cheever, John Howard.
A Chenery, William Elisha.
D Chenevert, Joseph Ovide.
D Cheney, Ernest Linwood.
A Cheney, Frederick Edward.
D Cheney, Harry Cleveland.
A Cheney, Oscar Dustin.
B Cherry, James B.
D Chesley, Alfred Ervan.
D Chesley, Alice Maud Mary.
D Chestnutt, Arthur Allan.
D Chevrette, Wilfrid.
B Chick, William Harrison.
C Chicoine, Isidore Hermanigilde.
A Child, Edward Moses.
D Childs, Alfred Henry.
A Childs, Helen Simonds.
A Chipman, Anna Mary.
A Chipman, William Reginald.
A Chirurg, Michael.
D Chisholm, Miles Dudley.
A Chisholm, William James.
A Chisholm, William Parmer.
D Choate, Alton Jay.
A Choate, David.
D Choate, Horace Henry.
E Cholerton, Herbert.
D Choquette, Hormidas.
E Choquette, Joseph Henry.
D Chorilan, Kirkor Hovhannes.
E Christian, Andrew Forest.
D Christie, Samuel Abraham.
D Chrystal, Michael Henry.

A Chubbuck, Lurana Abbie.
A Church, Adaline Barnard.
A Church, Benjamin Taylor.
D Church, Charles Albert.
A Church, Herbert Ashley.
D Church, Mary Violet.
D Church, Russell Shepard.
E Churchill, Donald.
E Churchill, John Darling.
C Chute, Arthur Lambert.
A Cilley, Daniel Plumer.
A Cilley, Orran George.
B Claflin, Anna Frances.
A Clancy, William Henry.
E Clap, Edmund Wright.
E Clapp, Arthur Martin.
A Clapp, Frank Horace.
A Clapp, Herbert Codman.
A Clapp, James Wilkinson.
B Clarendon, James Campbell.
D Clark, Albert Ulysses Franklin.
A Clark, Caleb Wakefield.
A Clark, Clinton Dewey.
A Clark, David.
D Clark, Edward James.
D Clark, Ezra W.
D Clark, Franklin Edward.
C Clark, Frederick Lincoln.
D Clark, Frederick Timothy.
D Clark, Genevieve.
A Clark, George Henry.
D Clark, George Oliver.
A Clark, George Stillman.
A Clark, Homer.
A Clark, Henry Frederick.
A Clark, James Colby Dorr.
A Clark, James Samuel.
D Clark, John Donovan.
A Clark, John Marther.
A Clark, Joseph Eddy.
A Clark, Joseph Leonidas.
A Clark, Julius Stimpson.
A Clark, Leonard Brown.
A Clark, May Chadbourn.
A Clark, Seth Corbin.
A Clark, Sidney Avery.
A Clark, Stephen Wilson.
D Clark, Thomas Francis.
A Clark, Theodore Wright.
D Clark, Walter Almon.
A Clark, Walter Thomas.
D Clark, William Goodwin Chadbourne.
A Clarke, Augustus Peck.
A Clarke, Edith Leavitt.
A Clarke, Edwin Augustus.
D Clarke, Elliott Mason.
A Clarke, George Clarendon.
D Clarke, George Haven.
A Clarke, George Salisbury.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Clarke, George William.
A Clarke, Henry Little.
D Clarke, Inez Louise.
A Clarke, Israel James.
B Clarke, John Henry.
A Clarke, Joseph Payson.
D Clarke, Joshua Williams.
A Clarke, Louis Henry.
A Clarke, Maurice Dwight.
A Clarke, Mortimer Hall.
D Clarke, Thomas Michael.
A Clarke, William Crocker.
C Clarke, William Johnson.
D Clarke, William Thomas.
E Clarkson, Thomas Carbarns.
D Cleary, James.
E Cleaves, Ezra Eames.
D Cleaves, Frederick Henry.
A Cleaves, James Edwin.
D Cleghorn, Allen MacKenzie.
D Clement, Allen Bell.
A Clement, George Colburn.
A Clement, George Wilmot.
A Clement, Lydia Ramsdell.
D Clement, Merton Wallace.
E Cleveland, Heber Howe.
D Cleveland, Theodore Parkman.
D Cliff, Alfred Addington.
A Cliff, Leander Albert.
C Clift, Joseph Wales.
A Clock, Frank Benson.
D Closson, Gershom Loveland.
E Closson, Leon Monroe.
D Cloudman, Harry Radcliffe.
B Clough, Charles William.
E Clough, Frank Herbert.
A Cloutier, Felix Joseph.
A Coady, Patrick Francis.
A Cobb, Albert Crocker.
A Cobb, Carolus Melville.
A Cobb, Charles Henry.
D Cobb, Chester Thomas.
A Cobb, Farrar Crane.
A Cobb, Frederic Codman.
A Cobb, Harriet Hodges.
D Cobb, Oliver Warren.
D Coburn, Horace Fordyce.
A Coburn, Henry Harrison.
A Coburn, William Franklin.
A Cochran, George Buck.
A Cochran, William James.
A Codding, Edwin Hayden.
C Codman, Ernest Amory.
E Cody, Joseph John.
A Cody, Edmond Francis.
E Coe, Richard.
D Coffey, Daniel David.
D Coffey, Leonard James.
A Coffin, Arthur Baylies.
D Coffin, Frank Herbert.
D Coffin, George Henry.
A Coffin, John Lambert.
A Coffin, Juliet Evelyn.
D Coffin, Rockwell Augustus.
D Coffrey, William Francis.
A Cogan, Joseph Ambrose.
E Cogan, Thomas Francis.
C Coggeshall, Frederic.
A Coggin, David.
A Coghlan, John Nichols.
A Cogswell, Charles Frederick.
A Cogswell, Charles Hale.
A Cogswell, Edward Russell.
A Cogswell, George Proctor.
A Cogswell, William, Jr.
D Cohan, Francis Henry.
D Cohill, David Young.
D Colburn, Frederick Wilkinson.
D Colburn, Harry Hayford.
A Colby, Edward Porter.
A Colby, Edwin Alonzo.
D Colby, Fred Bennett.
D Colby, Gilman.
D Colby, William Morrill.
A Colcord, Daniel Webster.
A Cole, Charles Higgins.
A Cole, David Smalley.
D Cole, Lorenzo Waite.
E Cole, Merton Kendrick.
A Cole, Ralph Marcus.
B Cole, Stillman Asbury.
A Cole, William Ezra.
A Coleman, Ellenwood Bunker.
D Coles, William Wharton.
D Colgate, Charles Henry, Jr.
A Collamore, Francis.
A Collet, Peter Achille Anaclet.
A Collier, Lawrence Henry Goodwin.
D Collin, Carl Oscar Louis.
D Collins, Aubrey John.
A Collins, David Aloysius.
A Collins, Edgar Clarence.
D Collins, George Lehman.
D Collins, John James.
A Collins, Orville William.
D Collins, Richard.
D Collins, Wallace Jason.
A Collins, William Drolen.
D Collins, William James.
D Conlin, Charles Francis.
A Colt, Henry.
A Colton, John Jay.
B Colvin, William Henry.
A Combs, Leander Warren.
A Comey, Perley Pierce.
D Comins, James Brooks.
A Comtois, Odilon Joseph.
A Conant, Thomas.
A Conant, William Merritt.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Conboy, Michael Aloysius.
A	Cone, Dwight Eleazer.
A	Congdon, Lennier.
E	Congreve, James Mandeville.
D	Conkey, Caroline Root.
D	Conklin, Jay Robert.
A	Conlan, Thomas.
D	Conlin, Joseph Michael.
A	Conlon, Andrew Aloysius.
A	Conn, Henry Leon.
A	Connell, Arthur Irving.
A	Connell, Charles Walter.
D	Conner, Chandos Burton.
D	Conner, Horace Leigh.
B	Connihan, Edward Joseph.
E	Connolly, John Matthew.
D	Connolly, William Edward.
D	Connor, Charles Frank.
A	Connors, Willett Spurgeon.
D	Conro, Arthur Clifton.
D	Conroy, Edward Cornelius.
A	Conroy, Peter John.
A	Constans, Frank Elmore.
B	Contré, Pacifique.
D	Conway, Francis Bernard.
A	Cook, Charles Henry.
A	Cook, George Andrews.
E	Cook, John William.
A	Cook, Mabell Melissa.
D	Cook, Philip Howard.
D	Cooke, Henry Arnold.
A	Cooke, Snow Parker Freeman.
D	Cooley, Abbott Lathrop.
A	Coolidge, Algernon, Jr.
A	Coolidge, David Goldthwait.
D	Coolidge, Frederic Shurtleff.
A	Coolidge, John Nelson.
E	Coolidge, Sumner.
D	Coon, George Bailey.
A	Coon, Marion.
D	Coon, Mary Jameson.
A	Cooper, Almon.
D	Cooper, Herbert.
A	Cooper, Hermon.
D	Collins, William Morris.
A	Copeland, Charles Ward.
A	Copeland, Elmer Humphrey.
A	Copeland, Horatio Franklin.
A	Copeland, William Henry.
A	Copp, Owen.
A	Corcoran, Luke.
A	Corey, Francis Edwin.
D	Corey, Frederick Hall.
D	Coriat, Isador Harry.
A	Corliss, Oscar Luzerne.
B	Cornbloom, Charles.
F	Cornish, Ellis Holmes.
D	Cornwell, Edwin Sylvester.
D	Cornwell, Herbert Cerdá de Vilarrestau.
D	Corr, Francis Xavier.
A	Corrigan, John Patrick.
E	Cort, Parker Martin.
E	Cosgrove, John Joseph.
D	Costello, John Henry.
A	Cote, Camille.
D	Cote, Honore Joseph.
D	Cotter, Maurice Edward.
A	Cotterell, Samuel Parker.
D	Cottle, Louis Albert.
D	Cotton, Curtis Briggs.
A	Cotton, Frederic Jay.
D	Cotton, Harry Andrews.
D	Couch, Oscar Roberts.
A	Couch, William Anthony.
C	Coues, William Pearce.
A	Coughlin, John William.
A	Couillard, Pierre Leonard.
D	Coulson, Richard.
A	Councilman, William Thomas.
A	Courtney, Joseph William.
E	Courtney, Samuel Edward.
A	Cousens, Nicholas William.
A	Couture, Michael Horatius.
E	Cowan, Marion.
A	Cowden, J. Morrow.
C	Cowdrey, Arthur Harris.
D	Cowern, Ernest William.
A	Cowles, Edward.
A	Cowles, Frank Augustus.
A	Cowles, Fred Waterman.
A	Cowles, Sigourney Trask.*
A	Cowles, William Norman.
D	Cox, Gardner.
D	Cox, Simon Francis.
D	Cox, Thomas.
A	Coy, Seth Willard.
D	Coyle, Walter Edward.
D	Coyne, James Augustine.
E	Coyne, Thomas Joseph.
A	Crabtree, Addison Darre.
D	Cragin, Donald Brett.
A	Cragin, Francis Milton.
A	Craig, Daniel Hiram.
A	Craigin, George Arthur.
A	Cram, John Wesley.
D	Cramm, William Edward.
D	Crandell, Arthur Richmond.
D	Crandon, Le Roi Goddard.
D	Crane, Bayard Taylor.
D	Crane, Carl Custer.
D	Crane, Clarence.
A	Crane, George Walker.
D	Crane, Stella Howard.
A	Crawford, Charles Henry.
D	Crawford, Francis Xavier.
E	Crawford, Howard Tribou.
A	Crawford, John William.
D	Crawford, Joseph Warrington.
A	Crawford, Sarah Marcy.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Crease, Henry George.	A	Cumston, Charles Greene.
D	Creesy, Everett Larcom.	A	Cundall, Charles Carol.
A	Crisand, Carl.	B	Cuneo, Augustus.
D	Crispo, Peter Timothy.	A	Cunningham, Benjamin Frazier.
D	Crittenden, Harrison Murray.	E	Cunningham, Edward Albert.
D	Crittenden, Samuel Wright.	D	Cunningham, John Henry, Jr.
D	Crittendon, Rufus Asaph.	A	Cunningham, Joseph Henry.
A	Croacher, Anna Wood.	A	Cunningham, Thomas Edward.
A	Crocker, Benton Pulsifer.	D	Cunningham, Patrick Vincent.
A	Crocker, John Myrick.	E	Cunningham, Wilfrid Bernard.
D	Crocker, Louis Allen.	D	Curley, Clarence Proctor.
A	Crocker, Susan Elizabeth.	D	Curley, George Frederick.
A	Crocker, Willard Crafts.	D	Curley, Walter James.
A	Crockett, Eugene Anthony.	A	Curran, Charles Henry.
B	Crockett, Fred.	A	Curran, Charles James.
A	Crockett, Frederick Eugene.	D	Curran, Simon Francis.
D	Croft, Benjamin Pomeroy.	A	Currie, John Zebulon.
D	Crofts, Nicholas Matthew.	A	Currier, Mary Barnard.
A	Cronin, Henry William.	A	Currier, May Carrie.
D	Cronin, Jeremiah Augustine.	E	Currier, Richard Doe.
D	Cronin, Joseph John.	D	Currier, William Eugene.
D	Cronin, Michael John.	A	Currier, William Hale.
D	Cronin, Thomas Joseph.	D	Curry, Edmund Farnham.
D	Crooker, Hiram Henry.	D	Curtis, Belle Dora.
D	Crosby, Frederic Chandler.	A	Curtis, Francis George.
D	Crosby, Leander Marshall.	A	Curtis, Hall.
D	Cross, Albert Elmer.	D	Curtis, Harlan Fuller.
A	Cross, Grace Ella.	A	Curtis, Henry Fuller.
A	Cross, Hiram Bliss.	B	Curtis, Thomas Mitchell.
D	Cross, Louis Kent.	D	Curtis, William Goodwin.
E	Cross, Rupert Calladon.	A	Cushing, Alvin Matthew.
D	Cross, William Patrick.	D	Cushing, Arthur Alden.
D	Crossland, Henry Mark.	A	Cushing, Ernest Watson.
A	Crossman, Frank Albert.	A	Cushing, Eugene Bonaparte.
A	Croston, John Francis.	A	Cushing, Hayward Warren.
D	Crotty, Thomas Henry.	A	Cushing, Ira Barrows.
C	Crowell, Hannah Hall.	A	Cushing, Oliver Fernald.
A	Crowell, Samuel.	A	Cushman, Andrew Barnard.
A	Crowell, Willis E.	A	Cushman, George Thomas.
D	Crowley, Ambrose.	D	Cushman, Mary Floyd.
A	Crowley, Jeremiah Francis.	D	Cusick, Lawrence Francis.
D	Crowley, John Michael.	D	Cusick, Thomas Francis.
B	Crowninshield, Phoebe.	D	Cutler, Alice Surry.
A	Crozier, Thomas.	A	Cutler, Cecil Stevens.
C	Cruikshank, Herbert Wyche.	A	Cutler, Charles Lewis, Jr.
D	Cudworth, Charles Duane.	E	Cutler, Charles Newton.
A	Culbert, Robert Ronayne.	A	Cutler, Edward Roland.
A	Culbertson, Emma Valeria P. B.	A	Cutler, Elbridge Gerry.
D	Cummin, John White.	B	Cutler, George.
D	Cummings, Alvah Cochran.	A	Cutler, James Tucker.
A	Cummings, Charles Stearns.	A	Cutler, William Bullard.
A	Cummings, Edwin Francis.	A	Cutter, Charles Kimball.
D	Cummings, Frederick Russell.	E	Cutter, Arthur Hardy.
A	Cummings, Irving Oscar.	A	Cutter, Ephraim.
D	Cummings, John Joseph.	A	Cutter, John Ashburton.
A	Cummings, Maria Louisa.	A	Cutter, John Clarence.
A	Cummings, Michael Aloysius.	D	Cutting, Charles Theodore.
D	Cummings, Morton Everett.	A	Cutts, Harry Madison.
A	Cummings, Mott Alvah.	D	Dacey, Cornelius Joseph.
B	Cummings, Willard Corydon.	D	Dadmun, Eliza Josephine.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

E	Dahlquist, Edward Bernhard.
A	Daigneault, Joseph Arthur.
D	Dailey, Edward Joseph.
D	Dailey, Richard Connell.
A	Daily, John Wesley.
A	Dake, Dumont Charles.
A	Dakin, Edward Arthur.
A	Dakin, Mary Anna Dorgan.
A	Dale, John Lombard.
A	Daley, Robert Nicholas.
D	Dalrymple, Addie Blanche.
D	Dalrymple, Alfred Tomblinson.
E	Dalton, Charles Francis.
D	Dalton, Charles Howard.
D	Dalton, John Edward.
D	Dalton, Martin James.
D	Dalton, Michael Henry.
A	Daly, Bernard Thomas.
A	Daly, James.
E	Daly, Jeremiah James.
A	Daly, Richard Francis.
D	Daly, Timothy Joseph.
C	Daly, William Joseph.
A	Dam, Alvah Morton.
D	Dame, Fred Russell.
A	Damon, Arthur Lewylenn.
A	Damon, Newcomb Lincoln.
A	Dane, John.
D	Danforth, Harland Abbott.
D	Daniel, Vivian.
A	Daniels, Edward William.
A	Daniels, Edwin Alfred.
E	Daniels, Roy Adelbert.
D	Darby, Edward Arthur.
D	Darby, Margaret Gurney.
D	Darling, Cassius Harriot.
A	Darling, Charles Balfour.
•A	Darling, Eugene Abraham.
D	Darmond, Alice Lavinia Kimball.
A	Darrah, Rufus Elmer.
D	Daudelin, Siméon Alphonse.
A	Davenport, Bennett Franklin.
A	Davenport, Charles Albert.
A	Davenport, Francis Henry.
D	Davenport, Frank Douglass.
D	David, Mary Ina Miles.
A	Davidson, Kallman Meyer.
A	Davie, Charles Herbert.
D	Davies, Thomas Franklyn.
A	Davis, Andrew Jackson.
D	Davis, Anna Belle.
A	Davis, Bessie Delano.
D	Davis, Charles Henry.
A	Davis, Edward Parker.
A	Davis, Ella Maxfield.
D	Davis, Francis Alvorde.
E	Davis, Frank Albert.
D	Davis, Frank Albin.
A	Davis, Frank Stewart.
A	Davis, Franklin Jerome.
A	Davis, Frederick Augustus.
A	Davis, Frederick Augustus.
D	Davis, Grace von Stauffer.
D	Davis, George Anthony.
D	Davis, George Healy.
D	Davis, Lincoln.
D	Davis, Minot Flagg.
D	Davis, Myron, Jr.
C	Davis, Myron Henry.
A	Davis, Nathan Johnson.
D	Davis, Percy Guy.
A	Davis, Roland Augustus.
A	Davis, Samuel Alonzo.
A	Davis, Samuel Thomas.
D	Davis, Stephen Rich.
A	Davis, Wesley.
B	Davis, William Everett.
D	Davis, William Henry.
E	Davis, William Horace.
B	Davis, William Philip.
D	Davis, Winnifred Puffer.
C	Davison, Archibald Thompson.
E	Davison, Arthur Howard.
A	Dawes, William Greenleaf.
A	Day, Clarence Currier.
B	Day, Henry Bailey.
E	Day, Hilbert Francis.
D	Day, James Arnold.
D	Day, Josiah Fisher.
A	Deal, Edward Edwin.
A	Deal, George Francis.
A	De Amezaga, Gualtiero.
D	Dean, Charles Henry.
D	Dean, Hubert Tidd.
D	Dean, Ralph Denniston.
A	Deane, Asahel Sumner.
A	Deane, Ebenezer Alexander.
A	Deane, Henry Augustus.
A	Deane, Wallace Harlow.
A	Deans, Herbert Clair.
A	Dearborn, Alvah Burton.
D	Dearborn, Henry Hale.
A	Dearborn, John George.
A	Dearborn, John Henry.
A	Dearborn, Reuben Fletcher.
A	Dearing, Henry Lincoln.
A	Dearing, Howard Summer.
A	Dearing, Thomas Haven.
A	De Beer, Johannes Benedict David.
A	De Blois, Thomas Amory.
E	Decker, William Nelson.
A	Dedrick, Albert Clinton.
A	Deehan, Peter Eugene.
D	Deely, George Edward.
E	Deering, George Edwin.
A	Defriey, William Peabody.
A	De Grandpré, Louis Philippe.
A	Dehn, Edward William.
A	Delahanty, William Joseph.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Deland, Charles Airmet.
A De Langle, Charles Petit.
A Delano, Marcus F.
A Delano, Samuel.
A De Laval-Thyernay, Melville Endore Forbin.
A De Liguori, Giovanbattista.
A Delisle, Joseph Damase.
A De Lue, Frederick Spaulding.
D De Marco, Tomasino.
A Dembo, Fanny.
D De Merritt, Charles Law.
D Demers, Adelard Olivier.
A Denig, Blanche Alpine.
A Denkinger, Joseph Anton.
D Dennen, Joseph Horace.
D Dennet, Charles Augustus.
D Dennett, Alonzo Gustin.
D Dennett, Daniel Clement.
A Dennett, George William.
A Dennett, John, Jr.
D Dennett, Roger Herbert.
E Denning, Edward John.
D Denning, William Edward.
A Dennis, James Henry.
C Dennis, Jane Louise.
D Dennison, Archibald Sayre.
C Denny, Francis Parkman.
A Denny, Harry Ernest.
A De Normandie, Myra.
D De Normandie, Robert Laurent.
E Depew, William Robertson.
B Derby, Emma Angeline.
D Derby, George Strong.
A Derby, Hasket.
A Derby, William Parsons.
D De Robertis, Antonio.
A Deroin, Francis Xavier.
D Derrick, George William.
D Derrick, Joseph Stephen.
D Dervin, Laurence James.
A Dervin, Peter John.
B Desmarais, Joseph.
A Desmario, Joseph Henry.
E Desmond, Clarence Francis.
A Desnoyers, Dontagne.
D Desrochers, Alfred.
D DesRosiers, Désiré.
A Desrosiers, Louis Amedie.
A Désy, Gustave.
D Devlin, Peter Clarke.
D Devenny, Joseph Henry.
A Dever, Charles Edward.
D Devere, Arthur Clarence.
D Devere, Fred Hewitt.
A Devereaux, Jane Smith.
A Devine, William Henry.
A Dewey, Charles Gipson.
A Dewis, John William.
A Dewolf, Edward Gardner.
E Dexter, Fred Fay.
D Dews, Frederic Gifford.
A Dexter, Ella Louisa.
A Dexter, Franklin.
D Dezell, Frederick Burr.
A Dickens, Job Byron Marcus.
A Dickerman, Silas Barnet.
D Dickerson, Spencer Cornelius.
D Dickinson, Amelia Ann.
A Dickinson, Charles Henry.
A Dickinson, Harvey Middleton.
D Dickson, Richard Ensign.
D Diemar, Lena Hess.
C Dike, John.
A Dillon, Thomas Joseph Bennett.
E Dillon, Richard Hastings.
A Dimock, Daniel Wright.
A Dinenson, Abraham Isaac.
A Dion, Thomas Joseph.
B Dionne, Louis.
B Dionne, Louis Edward.
D Disbrow, John Robert.
A Disbrow, Robert.
A Disney, Frank Arundel Elias.
D Dix, George Alfred.
A Dixon, Joseph Henry.
A Dixon, Lewis Seaver.
A Dixon, Robert Brewer.
A Dixwell, John.
A Doane, George Washington.
D Doane, Harriet M.
A Doble, Ernest Edgar.
D Dobson, Clarence Henry.
D Dodd, Isaac Spencer Finney.
D Dodge, Arthur Malcolm.
A Dodge, Fred Wilder.
A Dodge, William Wooldredge.
A Doggett, Frederick Fobes.
A Doherty, Charles.
D Doherty, Helen Isabel.
A Dolan, William Andrew.
D Dolan, William Edward.
E Dole, Charles Frederick.
A Dole, Mary Phylinda.
A Dolloff, Albert Simeon.
D Dolloff, Charles Hale.
A Doloff, Eugene Malcolm.
D Donahue, Francis William.
A Donahue, Hugh.
D Donahue, William Francis.
D Donaldson, Frederick August.
D Donaldson, James Frank.
D Donlan, Charles Edwin.
D Donlan, John Malachi.
D Donnell, Rufus Edwin.
D Donnelly, Augustine John.
D Donnelly, Harry Albert.
D Donnelly, James Harvey.
A Donnelly, John Bernard.
E Donner, John Albert.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Donoghue, Daniel Francis.
A	Donoghue, Francis Dennis.
D	Donoghue, James Crowley.
D	Donoghue, John Joseph.
E	Donohue, George.
A	Donovan, Benedict.
D	Donovan, John Joseph.
D	Donovan, Timothy Stephen.
C	Donovan, Michael Ricard.
D	Donovan, Sylvester Edward.
D	Doray, Frank Leslie.
A	Dorcey, James Edmund.
E	Dore, Francis James.
D	Dorgan, Joseph Aloysius.
D	Dorion, Jean Baptiste Theophile.
A	Dorion, Louis Philippe Adélard.
C	Dorman, Albert Barnes.
A	Dorman, Daniel Webster.
A	Dorr, Charles Alonzo.
E	Dort, Elizabeth.
A	Dorval, Tancrède Cesaire.
D	Doten, Arthur Chapman.
D	Doucett, Frederick Luke.
A	Douglas, Charles Joseph.
A	Douglass, John Abbott.
D	Dow, David Crooker.
A	Dow, Edmund Scott.
D	Dow, George Farwell.
A	Dow, George William.
A	Dow, James Arthur.
D	Dowd, Edward Francis.
D	Dowd, Michael Joseph.
C	Dowling, John Joseph.
A	Downey, Charles John.
D	Downey, Fred Clifton.
D	Downey, Henry Arthur.
D	Downey, William Henry.
E	Downing, Bertha Carol.
D	Downing, Charles Harland.
D	Downing, Dana Fletcher.
D	Downing, Franklin Chace.
A	Downs, Harry Ashton.
A	Doy, Wilberforce Clarkson.
A	Doyle, Daniel Patrick.
D	Doyle, Francis Henry.
D	Doyle, John Henry.
A	Drake, Arathena Bianca.
E	Drake, Arthur Knowlton.
D	Drake, Dean Spencer.
A	Drake, Norman Lucca.
D	Drake, Olin Milton.
E	Drake, Percy Greenough.
D	Drake, Richard Alvin.
A	Drake, William Abram.
D	Dranga, Amelia Augenia.
D	Draper, Alexis Lumb.
D	Draper, Arthur Derby.
D	Draper, Charles Ransom.
A	Draper, Frank Eugene.
A	Draper, Frank Winthrop.
A	Dresser, George.
D	Drew, Charles Aaron.
B	Drew, Frances Harriet.
A	Drew, Frank Haynes.
A	Drew, Frederick.
D	Drew, Frederick Prescott.
A	Drew, Maria Emma.
A	Driscoll, Thomas Daniel.
A	Driver, Stephen William.
E	Drohan, James Henry.
D	Dronin, Wilfrid George.
A	Drown, Edward Payson.
A	Drummey, Nicholas Daniel.
E	Drummond, Edward Augustine.
A	Drummond, Juan Fernandez Bennett.
D	Drury, Dana Warren.
D	Dreyfus, Edna Helen Weil.
D	DuBois, Eoline Beatrice Church.
D	Duckering, Florence West.
D	Duckering, William West.
D	Duclos, Aram Esrom.
C	Dudley, Augustus William.
E	Dudley, Charles.
A	Dudley, Henry Watson.
A	Dudley-Clapp, Susan Ida.
A	Duff, John.
D	Duffee, Thomas Edward.
A	Duggan, John Joseph.
A	Duggan, John Thomas.
D	Duhaime, Gandiose Lemaitre.
A	Duhamel, Oliva Gilbert.
B	Du Mont, Henry.
A	Dunbar, Frank Collins.
D	Dunbar, Frank Herbert.
A	Dunbar, Franklin Asaph.
B	Duncan, Florence Josephine.
D	Dunham, Frank Lee.
A	Dunham, George Perry.
A	Dunham, Henry Bristol.
D	Dunham, Whitefield Otis.
A	Dunlap, Charles Bates.
D	Dunn, Charles Hunter.
C	Dunn, Charles Stein.
A	Dunn, Jennie Sophia.
C	Dunn, William Aloysius.
A	Dunn, William Ambrose.
A	Dunne, Alexander John.
A	Dunning, William Meddaugh.
B	Dunphy, John.
E	Dunsmoor, Harrie Victor.
A	Dupont, Flavien.
B	Duquet, Philorome.
A	Durant, Charles Edwin.
A	Durell, Thomas Moulton.
D	Durgin, Edward Chase.
A	Durgin, Samuel Holmes.
D	Durning, Charles Francis.
A	Dutton, Charles.
A	Dutton, George.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Dutton, Julius Maltby.
D	Dutton, Richard.
C	Dutton, Samuel Lane.
A	Dutra, Emmanuel Christian.
C	Dutra, Joseph.
D	Dutrizac, Joseph Ovid.
D	Duval, Josias Louis.
A	Duxbury, Joseph Edward.
A	Dwelly, Jerome.
A	Dwight, Edwin Weller.
D	Dwight, Henry Leonard.
A	Dwight, Thomas.
A	Dwinell, Byron Lee.
D	Dwinell, William Grout.
A	Dwyer, John Edward.
D	Dyer, Charles Lathrope.
D	Dyer, Ebenezer Alden.
D	Dyer, Ernest Arey.
D	Dyer, Florence May.
B	Dyer, Frank Pierce.
B	Dyer, Willard Knowlton.
D	Dyer, William Henry.
D	Eames, Frederick Henry.
A	Eames, George Franklin.
A	Earl, George Henry.
A	Earle, William Alva.
D	Early, William Wallace.
D	Eastman, Albert Clinton.
D	Eastman, Alexander Crane.
A	Eastman, Charles Albert.
A	Eastman, Charles Albert.
D	Easton, Charles Daniel.
B	Eastman, Mary Roena.
D	Easton, Elwood Tracy.
A	Eaton, John Marshall.
A	Eaton, Lilley.
D	Eaton, Richard Gardner.
A	Eaton, Samuel Lewis.
A	Eaton, William Winslow.
A	Eaton, Wyllis Gilbert.
A	Ebann, Charles Deletang.
D	Ebbs, Bertha Evelyn.
B	Eckstein, Caroline Katherine.
A	Eddy, George Stetson.
A	Eddy, Hiram McCrery.
A	Eddy, Richard Henry.
A	Edes, Robert Thaxter.
A	Edgar, William Ladell.
A	Edgerly, Jonathan Frank.
D	Edmands, Idelle Lydia.
A	Edmonds, Louis.
A	Edson, Carroll Everett.
D	Edson, John Tracey.
A	Edson, Ptolomy O'Meara.
D	Edwards, Arthur Frank.
D	Edwards, Franklin Wallace.
D	Edwards, Merton John.
A	Edwards, Thomas Alvin.
A	Edwards, William Lothrop.
D	Eells, Joseph Oliver.
D	Egan, Edward Winfield.
C	Egan, John Joseph.
B	Egan, Sebra Temple.
D	Egbert, Jay Hobart.
C	Egland, Christopher.
E	Ehrenfried, Albert.
D	Ehrich, William Seigman.
A	Ehrlich, Henry.
D	Eidam, Carl Hermann.
A	Ela, Paul Francis.
A	Ela, Walter.
D	Elcock, Harry Alfred.
B	Elderen, John Van.
B	Eldridge, Benjamin Davis.
A	Eldridge, David Gorham.
D	Eldridge, Harvey Loud.
A	Eldridge, Jerrie Allen.
D	Eliot, Henry Whitney.
D	Ellam, Herbert William.
D	Elliot, Henry Libby.
A	Elliot, John Wheelock.
D	Elliot, Sidney Barrington.
D	Elliott, Alfred.
A	Elliott, James Prescott.
E	Elliott, James William.
D	Elliott, Richard Andrew.
A	Elliott, Russell Dunson.
A	Ellis, Charles Curtis.
A	Ellis, Dean Samuel.
A	Ellis, Edward Harvey.
D	Ellis, Edward Keith.
A	Ellis, Frederick Warren.
A	Ellis, George Livingston.
D	Ellis, Robert Hale.
E	Ellis, Sidney Allan.
D	Ellis, William Raymond.
A	Ellison, George Washington.
D	Ellsworth, Samuel Walker.
A	Ellsworth, Victor Albert.
D	Elmere, John Alfred.
D	Ely, Richard Skinner.
D	Emerson, Benjamin Kendall, Jr.
A	Emerson, Charles Sumner.
D	Emerson, Ernest Benjamin.
A	Emerson, Francis Patten.
A	Emerson, Frederick Lincoln.
D	Emerson, George Edward.
D	Emerson, George Short.
A	Emerson, George Washington.
A	Emerson, Herbert Clark.
A	Emerson, Nathaniel Waldo.
D	Emerson, Robert Leonard.
D	Emerson, William Roble Patten.
D	Emery, George Edwin.
D	Emery, Harry Smith.
E	Emery, Robert Dudley.
E	Emery, William Campbell.
A	Emery, William Henry.
A	Emery, Winfred Newell.
D	Emmons, Arthur Brewster.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Emmons, Henry Manning.
D Enebuske, Claës Julius.
D England, Albert Charles.
A Ensworth, William Howard.
A Entin, Gilel.
C Erb, Theodore Charles.
E Erickson, Anna Maria.
E Ericson, Erica.
A Ermentrout, Sallie Justinia.
A Ernst, Harold Clarence.
D Erving, William Gage.
D Eskelin, Karolina Sidonia.
D Estabrook, Charles Taylor.
D Estes, Florella.
D Etienne, Arthur Octave, Jr.
E Evans, Albert.
B Evans, David.
D Evans, John William.
D Evans, Joseph Harold.
D Evans, Miner Harlow Amos, Jr.
D Eveleth, Charles Wonson.
A Eveleth, Edward Smith.
D Eveleth, Fred Shaller.
E Everett, Eugene Ellsworth.
D Everett, Frederick.
A Everett, Horace Stanwood.
A Everett, James Bradley.
A Everett, Oliver Austin.
A Everett, Oliver Hurd.
A Everett, Willard Shepard.
D Everhard, Eleanora S.
C Ewald, Carl Adolph.
D Ewing, Edward Hilts.
D Ewing, George Winburn.
D Fagan, George Augustus.
A Fagnant, Benjamin.
A Fahey, James Charles.
D Fair, John Francis.
D Fair, Robert Patrick.
A Fairbanks, Arthur Willard.
A Fairchild, Courtland de Normandie.
D Fairhurst, O'Connell.
D Fairing, John Walker.
D Fales, Alonzo Cartland.
D Falkenbury, Arthur Ezra.
A Fallon, Michael Francis.
D Falvey, Humphrey John.
D Faria, João Baptista de.
A Farley, William Chase.
A Farlow, John Woodford.
D Farmer, Frank Emerson.
A Farnham, Charles Chittenden.
A Farnham, Edwin.
A Farnham, Mary Eudora.
C Farnham, John Marshall Willoughby.
B Farnsworth, Sarah Elizabeth.
D Farnum, Mary Louise Rolfe.
D Farquhar, William Abercromby Gordon.
A Farr, Edwin Lawson.
D Farrell, George Louis.
C Farrington, Annie Louise.
A Farrington, Leander Morton.
A Farwell, George Davis.
E Fassett, Fred Julius.
A Faulkner, Henry Clay.
D Faulkner, William Edward.
D Faunce, Calvin Barstow, Jr.
A Faunce, Robert Harris.
D Favour, Richmond, Jr.
D Fawcett, Deborah.
A Faxon, Eudora Meade.
D Faxon, Eudora Winifred.
E Faxon, Nathaniel Wales.
C Faxon, William Lyman.
A Faxon, William Otis.
D Fay, Charlotte Hooker.
A Fay, Frank Gleason.
A Fay, James Monroe.
D Fay, Joseph Henry.
A Fay, William Eastman.
D Fearl, Fred Henry.
E Fearney, Frank Albert.
D Fecteau, Adelard.
E Feeley, Charles Philip.
D Feindel, Joseph Creighton.
B Fellows, George Robert.
D Fenelon, Katherine Agnes.
D Fennessey, John Francis.
D Fenwick, George Benson.
A Fenwick, Joseph Benson.
A Ferguson, Arthur Bixby.
A Ferguson, Charles John.
D Ferguson, Creighton.
E Ferguson, Edward Hugh.
A Ferguson, Hugh.
D Ferguson, Robert.
D Ferguson, Robert Henry.
A Ferland, Joseph Severin Ernest.
A Fernald, Charles Augustus.
D Fernald, Guy Goodwin.
C Fernald, Herbert Elwood.
A Fernald, Otis.
A Fernald, Walter Elmore.
A Ferrari, Francesco Edoardo.
D Ferrin, William Warren.
D Ferris, Phoebe Annie.
A Ferry, James Francis.
A Fesler, Frank Joy.
A Fessenden, Charles Hill.
A Fessenden, George Russell.
A Fessenden, Joseph Palmer.
A Fewell, Samuel Jackson.
A Fick, Hermann Andrew.
D Fickett, Jerome Perley.
A Field, Charles Elmer.
D Field, Harvey Adams.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Field, Henry Martyn.
A Field, James Brainerd.
D Field, Martin Thomas.
A Field, Phinehas Peck.
A Field, Susan Hammond.
A Fillebrown, Charles Dalton.
A Fillebrown, Thomas.
D Finch, Edward Bronson.
D Finch, George Hardy.
D Finkelstein, Harry.
A Finn, Edward William.
A Finn, James Anthony.
D Finnegan, Daniel Joseph.
A Finnegan, Patrick Joseph.
D Fischbein, Louis.
D Fish, Ernest Clifford.
D Fish, Louis.
A Fish, Ralph Charles.
A Fisher, Edgar Alexander.
D Fisher, Irving Jewell.
D Fisher, James Tucker.
A Fisher, Theodore Willis.
D Fishman, Abraham Pincos.
A Fisk, Charles Lee, Jr.
D Fisk, Samuel Augustus.
A Fisk, William Willard.
A Fiske, Eustace Lincoln.
D Fiske, Harlo Adoniram.
A Fitch, Edward Doolittle.
D Fitch, Ralph Boswell.
D Fitts, Alston.
A Fitz, George Wells.
D Fitz, Mary Isabella Montgomery.
A Fitz, Reginald Heber.
D Fitzgerald, Charles Francis.
D Fitzgerald, Clara Pauline.
A Fitzgerald, James Bernard.
D Fitzgerald, John Joseph.
D Fitzgerald, Maurice Edward, Jr.
D Fitzgerald, Thomas Patrick.
D Fitzgerald, Vance Lee.
D Fitzgibbon, Edwin James.
A Fitz-Hugh, John Alexander.
D Fitzpatrick, John Joseph.
A Fitzsimmons, Philip Mansfield.
A Flagg, Alpheus Dexter Smith.
A Flagg, Edwin Barber.
D Flagg, Elisha.
C Flagg, Franklin Parkinson.
B Flagg, Jonathan.
A Flagg, Payson Jonathan.
D Flanagan, Peter Joseph.
D Flanders, Alton Leroy.
A Flanders, Frank Byron.
D Flanders, Walter Hubert.
A Fleet, William Earnest.
D Fletcher, Robert Swan.
A Fletcher, Robert Whitney.
A Fletcher, Rosa.
A Fletcher, Samuel Ernest.
A Fletcher, Samuel William.
A Fletcher, William Kelly.
D Flett, Penelope McNaughton.
D Fleming, Edwin Rahn.
D Fleming, Margaret Amanda.
D Fleming, Patrick Joseph.
D Fleming, Peter Joseph.
D Flemming, Anthony.
A Flewelling, Douglas Scovil.
A Flinn, Matthew Bonner.
A Flint, Charles Cookeman.
E Flint, Edward Rawson.
A Flint, Omar Alpha.
A Flood, Everett.
D Flood, Thomas Wilfred.
A Flower, Alfred Hollis.
A Flower, Richard Charles.
E Flynn, Henry Lawrence.
E Flynn, John Edward Leo.
A Flynn, John Joseph.
D Flynn, John Joseph.
A Fogerty, Williams Clemmons.
A Fógg, Irving Sylvester.
D Fogg, Walter Augustus.
A Foley, Timothy John.
A Foley, Walter James Paul.
A Follett, Ammi Ward.
A Follett, John Atwood.
D Floyd, Cleaveland.
A Folsom, Charles Follen.
A Fontaine, Marc.
C Fontaine, Henri Theophile.
A Forbes, Charles Holt.
E Forbes, Edwin Bannister.
A Forbes, George Foster.
A Forbes, Henry Gordon.
A Forbush, Albert Waldo.
B Ford, Daniel Frank.
A Ford, John Francis.
D Ford, Michael Angelo.
B Forrest, Josephine Winifred.
D Forster, Robert William.
A Fortin, Julian Elzéar.
D Fosgate, Elmer Gilman.
D Foskett, Eben.
A Foskett, George Mason.
E Foss, Alvin Warren.
A Foss, David.
A Foss, John William.
E Foss, Percy Harold.
A Foss, Warren Sartwell.
A Foster, Charles Chauncy.
D Foster, Clarendon Atwood.
A Foster, Edwin Scott.
E Foster, Ellis Edwin.
A Foster, Frank Albert.
E Foster, Frank Brooks.
D Foster, George Benjamin.
A Foster, George Emory.
A Foster, Horace Kendall.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Foster, James Milton.
A	Foster, James Richards.
D	Foster, Louis Everett.
D	Foster, Matthias Lanckton.
E	Foster, William Augustus.
D	Foster, Winifred Smith.
D	Fountain, Oliver Reynolds.
A	Fountaine, Felix Dydime.
D	Fournier, Arthur.
C	Fourtin, Edmund Randolph Peaslee.
A	Fox, William Yale.
A	Foye, Charles Frederick.
A	Frame, Joseph.
E	France, Rowe.
C	Francis, Adeline Eliza.
A	Francis, Carleton Shurtleff.
A	Francis, George Ebenezer.
A	Francis, George Hills.
A	Francis, Tappan Eustis.
A	Francois, Edward Albert Louis.
A	Franfaglia, Gabriéle.
D	Frankel, Charles Louis.
B	Franks, Baron.
A	Franz, Adolph.
E	Fraser, Agnes.
A	Fraser, Donald Allan.
A	Fraser, John Chisholm.
D	Fraser, Frederic Lawson.
D	Fraser, Margaret Ethel Victoria.
D	Fraser, Roderick.
D	Fraser, William Leslie.
E	Frasier, Joseph Anthony.
B	Fréchette, Clément.
E	Freedman, Louis Mark.
A	Freeman, Franklin Willard.
A	Freeman, Frederick Augustus.
D	Freeman, George Franklin.
A	Freeman, Russell Ballou.
A	Freeman, Simon Augustus.
A	French, Alfred Joseph.
A	French, Charles Austin.
A	French, Charles Ephraim.
A	French, Charles Henry.
A	French, Charles Lindol.
A	French, Charles Peaslee.
D	French, Edward Henry.
A	French, George Henry.
D	French, John Innes.
A	French, John Marshall.
E	French, Towneley Thorndike.
D	French, Warren Kilburn.
A	French, Winslow Burrell.
D	Friedman, Leo Victor.
E	Frietas, José Carlos de.
B	Frink, Charles Tatman.
D	Frink, Claude Augustine.
D	Frink, Lewis James.
A	Frisbie, Jesse Franklin.
A	Frissell, Edward Merle.
A	Frizzell, Seraph.
B	Frost, Charles Chauncy.
A	Frost, Edward Clayton.
D	Frost, Flora Eva.
D	Frost, Horace Bird.
D	Frost, Samuel Kapp.
A	Frost, Woodbury George.
D	Frothingham, Charles Benjamin.
A	Frothingham, James Edward.
D	Frumson, Lazarus.
A	Fry, Charles Wilson.
A	Frye, Charles Marshall.
A	Frye, Edmund Bailey.
A	Fryer, Winson Farnum.
B	Fuller, Amos Warren.
D	Fuller, Charles Benjamin.
A	Fuller, Daniel Hunt.
D	Fuller, Elmer Ellsworth.
D	Fuller, Ernest Page.
D	Fuller, Etheridge Ide.
D	Fuller, Frank Boutelle.
A	Fuller, Frederick Henry.
B	Fuller, George Albion.
A	Fuller, George Ephraim.
A	Fuller, James Robert.
D	Fuller, Solomon Carter.
B	Fuller, Walter Tracy.
D	Fullerton, Walter Wilson.
D	Fulton, George Herbert.
D	Furniss, Maud Granger.
E	Furrer, Arnold Frotcham.
A	Fyfe, Thomas Tass.
D	Gabler, George Lewis, Jr.
D	Gaboury, Henri Tancrede.
A	Gaertner, Alexander.
D	Gaffney, James Francis.
A	Gaffney, John Patrick.
A	Gaffney, Henry Joseph.
D	Gafney, Harry Dabol.
A	Gage, Edward Franklin.
A	Gage, Homer.
A	Gage, James Arthur.
A	Gage, Thomas Hovey.
D	Gageby, Lenore Hamilton.
A	Gaggioli, Girolamo.
A	Gahan, Edward William.
D	Gahan, Myles Joseph.
D	Gahan, Patrick Francis.
D	Gaidzakyan, Ohan.
D	Gaillardet, Philippe.
B	Galbenewetz, Benjamin Goth.
A	Gale, George Washington.
D	Gale, Harold Adams.
B	Gallagher, James Thomas.
D	Gallagher, John Henry.
D	Gallagher, John Vincent.
D	Gallagher, Thomas Morton.
D	Gallagher, William Howard.
D	Gallant, Isidore.
A	Galligan, Edward Francis.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Galligan, Edward Joseph.
C Galligan, Eugene Thomas.
A Gallison, Ambrose John.
A Gallison, Henry Hammond.
A Gallivan, William Joseph.
A Galloupe, Benjamin Franklin.
A Galloupe, Charles William.
A Galloupe, Isaac Francis.
D Galvin, Augustus Hughes.
A Galvin, George William.
A Galvin, William.
E Gammell, Samuel.
A Gannett, William Whitworth.
A Gannon, Annie Margaret.
B Gannon, Anna Maria.
A Garceau, Edgar.
A Gardiner, Perley Forest.
D Gardner, Archibald Robert.
D Gardner, Charles Wesley.
A Gardner, Clarence Rhodolphus.
D Gardner, David Moulton.
A Gardner, Edward Everett.
A Gardner, Frank Augustine.
A Gardner, George Henry.
D Gardner, Harry Milton.
A Gardner, William Wallace.
A Garey, Charles Wendell.
B Garfield, John.
A Garlepy, Joseph Camille.
A Garland, Albert Stone.
D Garland, Cornelius Nathaniel.
D Garland, Frederick Eugene.
D Garland, George Franklin.
A Garland, George Minot.
A Garland, Guy W.
A Garland, Joseph Everett.
D Garland, Roy.
A Garmon, John Oscar.
A Garneau, Joseph Pierre Alphonse.
D Garrett, Frank Steele.
A Garrigan, Thomas James.
A Gary, Clara Emerette.
D Gary, William Henry Harrison.
D Gatchell, David Harris.
D Gates, Ernest A.
D Gates, George Cushman Coleman.
A Gates, George Wellesley.
D Gates, James Moseley.
B Gauthier, Franklin.
A Gavin, George Freebern.
A Gavin, John Harrison.
E Gavin, Joseph Leo.
A Gavin, Michael Freebern.
A Gavin, Patrick Freebern.
A Gay, Almon De Bois.
A Gay, Arthur Park.
D Gay, Clarence Bertram.
D Gay, Fritz Walter.
A Gay, George Washington.
A Gay, Ellen Angeline Kidder Hutchinson.
E Gay, Herbert Seymour.
B Gay, Mary Cochran.
A Gay, Warren Fisher.
E Gay, William Frederick.
D Gay, William Madison.
A Gaylord, John Flavel.
E Gaylord, William Avery.
A Geddes, Peter Spearce Walker.
D Gehring, Norman John.
A Gelineau, Charles William.
A Gelineau, Ovila Clément.
A Gendron, Joseph Alexander.
A Gendron, Joseph Etienne.
D Generalis, Demosthenes John.
A Genereux, Joseph Albérie.
A Genereux, Joseph Oliver.
D George, Arthur Phillips.
D George, Frank William.
A George, Oscar Fowler.
D Germain, Harry Homer.
A Gerould, Joseph Bowditch.
A Gerry, Edwin Peabody.
D Gerstein, Morris.
D Gerin-Lajoie, Mederic Thomas.
B Gertz, William Henry.
A Gervais, Emery.
A Getchell, Albert Colby.
C Getchell, Stillman Perry.
D Gettings, Thomas Lawrence.
D Gibbons, Lister.
E Gibbons, Sherwin.
A Gibbs, Howard Augustine.
D Gibbs, Joseph Addison.
A Gibbs, Linnaeus Victor.
A Gibbs, Lucero Jackson.
A Gibbs, Samuel Whelpley.
D Gibbs, Susan Burley Harris.
A Gibby, Isabel Parker.
A Giblin, Frank Joseph.
A Gibson, Arthur Allen.
B Gibson, Elwyn Deloss.
E Gibson, Robert Francis.
A Gidman, Bramwell Carvosso.
A Gifford, Benjamin Dods.
A Gifford, Fred Hooker.
A Gifford, John Henry.
D Gifford, Nathaniel Howland.
A Giguere, Joseph.
A Gilbert, Aurelia Eliza.
A Gilbert, Daniel Dudley.
D Gilbert, Frank Leslie.
A Gilbert, John.
D Gilbert, Louis Whitmore.
E Gilchrist, Charles Robert.
A Gildee, James Bennett.
A Gile, John Martin.
B Gilfether, Frank Emmet.
D Gilfillan, Donald Robert.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

C	Gilfillan, Thomas.
D	Gill, Mary Eva.
D	Gillard, Arthur Ernest.
A	Gillespie, John.
D	Gillette, Claudius Wesley.
D	Gillingham, Horace Porter.
D	Gillis, Andrew Colin.
A	Gilman, Eugene Albert.
D	Gilman, Frank Madison.
A	Gilman, Warren Randall.
D	Gilmartin, Albert Edward.
C	Ginn, David Richards.
E	Girard, Leopold Adolphe.
D	Girdner, John Harvey.
A	Girouard, Simeon Joseph.
D	Girouard, Joseph Arthur.
D	Giroux, Charles.
A	Giroux, Joseph Raymond.
D	Giurukes, Athanasio.
A	Glancy, Charles Augustine.
B	Glancy, William Carte Minnette.
D	Glass, James.
A	Glazier, Frederick Prentiss.
D	Gleason, Benjamin Whitney.
A	Gleason, Charles Sherman.
D	Gleason, Edward Francis.
A	Gleason, Edwin Putnam.
E	Gleason, George Hathaway.
A	Gleason, Mardis Edward.
D	Gleason, Willis Webster.
A	Glendenning, Robert Thompson.
A	Glennon, Michael.
E	Glidden, Howard Kenneth.
A	Gobron, Louis Constant.
D	Goddard, Abigail Elma.
D	Goddard, Henry Edward.
A	Goddard, Josiah Hamilton.
D	Goddard, Samuel Warren.
A	Godfrey, Joseph Witter.
D	Godfrey, Thomas Francis.
A	Godin, Joseph.
E	Golden, Lazarus.
A	Golden, Michael Charles.
A	Goldthwait, Joel Ernest.
A	Goldthwaite, Seth Vale.
D	Good, Frederick Leo.
A	Goodale, George Lincoln.
A	Goodale, Joseph Lincoln.
D	Goodall, Ellis Leon.
D	Goodall, Harry Winfred.
D	Goodall, Henry Skinner.
A	Goodell, George Zina.
D	Goodenow, Daniel.
A	Gooding, Emma Jeanette.
A	Goodman, Nathan Mark.
A	Goodman, Samuel.
D	Goodridge, Frederick James.
A	Goodspeed, Helen Amanda.
A	Goodwin, Charles Otis.
D	Goodwin, Edward Everett.
D	Goodwin, Elmer Ellsworth.
A	Goodwin, George Erving.
D	Goodwin, Harold Carl.
A	Goodwin, James Joseph.
A	Goodwin, Richard James Plumer.
A	Goodwin, Tirzah Eveline.
A	Goodwin, Wilford Watson.
A	Goray, James Philip.
A	Gordon, John Alexander.
A	Gordon, Miles Remond.
C	Gordon, Stephen Masury.
A	Gorham, Frederic Croswell.
D	Gorham, George Hartley.
D	Gorman, John William.
D	Gormly, Harry Hemming.
A	Gorshel, Richard.
A	Goss, Arthur Vincent.
A	Goss, Francis Webster.
A	Gottschalk, William von.
D	Goyer, Joseph Rodolphe.
D	Gould, Alfred Henry.
A	Gould, Charles Asahel.
A	Gould, Clarke Storer.
D	Gould, Chester Harlow.
B	Gould, Forrest Burton.
A	Gould, Frank Moriah.
D	Goulding, Timothy Francis.
D	Grace, Ralph.
E	Grady, Eliza.
E	Grady, Henry Matthew.
B	Grady, John William.
A	Grady, Joseph William.
D	Grady, Patrick Anthony Salmon.
D	Grady, Thomas Henry.
A	Graham, Douglas.
D	Graham, Maria Louise.
D	Grainger, Edward John.
A	Grainger, William Henry.
D	Grandison, Wilfred George.
D	Granger, Eugene Norton.
E	Granger, Frank Butler.
A	Granger, Frank Clark.
D	Granger, Karle Henry.
A	Grant, James Henry.
A	Grant, James Henry.
A	Grant, William Herbert.
D	Grant, William Victor.
D	Graves, Benjamin Augustus.
D	Graves, James Chapman, Jr.
E	Graves, Frederick Clinton.
D	Graves, Robert John.
E	Graves, Walter John.
D	Graves, William Phillips.
D	Gray, Alice Maude.
A	Gray, Charles Henry.
D	Gray, Charles Perley.
D	Gray, Elizabeth Taylor.
A	Gray, George Henry.
E	Gray, Hugh Barr.
A	Gray, Robert Williams.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Greany, Annie Gertrude.
E Greaves, John George.
D Greco, Francesco Saverio.
A Greeley, William Henry.
D Green, Abraham.
A Green, Charles Montraville.
A Green, Gyôre.
A Green, John Orne.
A Green, Milbrey.
D Green, Nathan Williams.
A Green, Thomas William.
D Greenaugh, Robert Battey.
E Greene, Daniel Crosby, Jr.
A Greene, Edward Miller.
D Greene, Eva Keith.
A Greene, Frank Alonzo.
A Greene, Frank Eugene.
A Greene, Harrie William.
A Greene, James Sumner.
A Greene, Jared Alonzo.
D Greene, Ransom Alphonzo.
A Greene, Ray Woodville.
A Greene, Robert Anderson.
A Greene, Thomas Francis.
D Greene, William Addison.
D Greene, William Henry.
D Greenfield, Melvin L.
A Greenleaf, George Walter.
A Greenleaf, John Ruggles.
A Greenleaf, Richard Cranch.
D Greenough, Clara Mary.
A Greenwood, Allen.
D Greenwood, Arthur Moses.
A Greenwood, Sewell Elliott.
A Gregg, John Argelo.
B Gregoire, Albert.
D Gregory, George Augustus.
A Grieumard, George Augustus.
B Griffin, Alva James.
A Griffin, Arthur George.
D Griffin, Frederic Stanley.
A Griffin, Louise Amanda.
D Griffin, Nathan Leroy.
D Griffin, Walter Alden.
A Griffith, John Auckland.
D Griffith, Thomas Richards.
D Griffiths, Albert Farnsworth.
E Grimes, James Henry.
D Grimes, Loring.
D Grimes, Warren Parker.
A Grinfield-Coxwell, John Edward.
B Grise, Herman Pierre.
D Griswold, Merton Lyman.
A Groll, Edward Wright.
E Groppner, Max Carl.
D Gross, Hermann Williams.
D Grossman, Max.
A Grouard, John Shackford.
D Grover, Arthur Leon.
D Grovestein, William Pride.
A Grow, Timothy Rose.
A Gruver, Samuel James.
A Guertin, Auguste.
A Guild, Edgar Hunt.
A Guild, Edward Frank.
D Guild, Thomas Ezra.
D Guiler, Robert Workman.
D Guilshan, Joseph John.
D Guimond, Omer.
D Gulick, Luther Halsey.
A Gunning, Thomas Francis.
A Gunter, Fred Berkeley.
A Guptill, Ira Clark.
A Guptill, Lucian Hayden.
D Gurley, Revere Randolph.
D Gustin, Genevieve.
D Guy, Walter Bryant.
D Gwin, Robert Campbell.
D Haché, Henry Clement.
A Haddock, Charles Whitney.
E Hagen-Burger, Gothfried Leonhard.
A Hagopian, Sarkis Morkir.
A Hahn, Ammi Rahamah.
D Haig, Andrew Atchison.
D Haigis, Peter.
D Haines, Ignatius.
A Hale, Edward Preston.
A Hale, Edwin Emery.
B Hale, George Carleton.
D Hale, Robert Carleton.
D Hale, William.
B Hale, William Alonzo.
E Hale, Willis Le Baron.
C Hall, Charles Brackett.
D Hall, Charles Francis Adams.
A Hall, Charles Henry.
D Hall, Fred Augustus.
D Hall, Gardner Wells.
A Hall, George Clifton.
D Hall, Herbert James.
D Hall, Harry Porter.
E Hall, James Frank.
D Hall, James Sanberg.
D Hall, John Baptiste, Jr.
A Hall, Mahlon Freeborn.
A Hall, Newbert Jackson.
D Hall, Rufus Hacker.
D Hall, Walter Davis.
A Hall, Walter Langdon.
D Hall, William.
A Hall, William Dudley.
A Hallett, Edward Bangs.
A Hallett, Walter Lewis.
D Halligan, Edward Maurice.
A Halloran, Michael Joseph.
E Halloran, Timothy Joseph.
A Hallowell, Clement Howard.
A Hallowell, Henry Carleton.
C Halpin, Andrew James.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Halsall, Mary Elizabeth.
D Halsted, Alfred Thompson.
A Halsey, Frederick Wadsworth.
D Ham, William Addison.
D Hamblen, Edward Everett.
D Hamblen, Howard.
D Hamilton, Annie Lee.
E Hamilton, Edward Sylvester.
E Hamilton, Frank Andrew.
D Hamilton, Robert De Lancey.
A Hamilton, Theodore Erskine.
D Hamilton, William Francis.
D Hamlin, William Edward.
A Hammersley, Jonathan Beadmore.
A Hammond, Allen Dexter.
D Hammond, Charles.
A Hammond, Lemuel Hodges.
A Hammond, Philip.
D Hammond, Roland.
D Hammond, William John.
A Hammond, William Penn.
A Hands, Anna Carville.
A Hands, Herbert Abraham.
A Handy, Benjamin Jones.
A Handy, Harrie Delmar.
D Handy, Harry Tucker.
A Hanley, Francis Joseph.
A Hanley, John Joseph.
A Hanlon, Daniel James.
D Hanlon, Joseph Peter.
A Hanna, Edmund Steelman.
D Hanna, Thomas Francis.
D Hannaford, Charles William.
A Hannum, James Wilson.
D Hanscom, Walter Vose.
A Hanscom, Sanford.
A Hanson, Frederick Augustus Tafte.
D Hanson, Justus Greely.
A Hanson, William Green.
D Hapgood, Lyman Sawin.
D Harding, Ambrose Hastings.
A Harding, Edward Mitchell.
A Harding, George Franklin.
D Harding, Walter Allen.
D Hardwick, Everett Vinton.
E Hardwick, Frederick Veazie.
A Hardy, Charles Silenus.
D Hare, Andrew Jackson.
A Hare, Charles Henry.
D Hare, William Andrew.
B Hargrove, Alfred.
B Hargrove, Frances Flora.
B Hargrove, Sidney Bulwer.
E Harkins, Cornelius Patrick, Jr.
A Harkins, Daniel Stanislaus.
D Harkins, John Francis.
A Harlow, Corydon Webster.
A Harlow, George Arthur.
A Harlow, Granville Albert.
A Harlow, Harriet Susan.
A Harlow, John Martyn.
D Harman, Austin Roy.
A Harmon, Byron Richmond.
A Harmon, Melville Alphonzo.
D Harper, Alfred Alfonso.
A Harriman, Charles Henry.
D Harriman, Cora Elizabeth.
D Harriman, David Eugene.
A Harriman, James Lang.
D Harriman, Perley.
A Harriman, Samuel Knight.
A Harrington, Arthur Hudson.
A Harrington, Charles.
D Harrington, Charles Woodbury.
A Harrington, Francis Bishop.
A Harrington, Francis Michael.
A Harrington, Harriet Louisa.
A Harrington, Thomas Francis.
D Harrington, Michael William.
D Harris, Arthur Eugene.
D Harris, Charles Edward.
A Harris, Emanuel.
A Harris, Francis Augustine.
A Harris, Georgianna Warren.
E Harris, Samuel Jacob.
B Harris, Sophia Roper.
E Harris, Wilfred Ernest.
D Harris, William DeBlois.
D Harris, William Landow.
A Harrower, David, Jr.
B Hart, Charles Oliver.
E Hart, Francis Joseph.
A Hart, George Fred.
D Hart, Henry Brown.
D Hart, James Overton.
E Hart, Joseph Storer.
B Hart, Mary Schoonmaker.
D Hart, Michael Joseph.
A Harte, Richard Hickman.
A Hartley, Henry Alexander Saturnise.
D Hartley, Rebecca Agnes.
D Hartman, Gustave.
D Hartnett, Edward Daniel.
D Hartshorn, Edward.
D Hartung, Harry Hall.
D Hartwell, Arthur Spear.
A Hartwell, Edward Mussey.
D Hartwell, Harry Fairbanks.
D Hartwell, William Winn.
B Harvey, Alvah.
A Harvey, Edwin Bayard.
B Harvey, Elvira Adelaide.
E Harvey, Frank.
A Harvey, Frank T.
A Harvey, Henry Sydney.
A Harvey, John Franklin.
D Harvey, Roland John.
A Harvey, Walter Emerson.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Harvey, William Wirt.
A	Harwood, Charles Hamant.
D	Hasbrock, Ira Daniel.
D	Haskell, Harris Bigelow.
A	Haskell, Henry Hill.
D	Haskell, Lyman George.
A	Haskell, Nelson Cary.
D	Haskins, Frank Eugene.
D	Haskins, Frank Henry.
A	Haskins, Solomon Foot.
A	Haslam, Frank Alden.
A	Hassett, John Joseph.
A	Hastings, Caroline Eliza.
B	Hastings, Frank Josiah.
D	Hastings, John Mason.
A	Hastings, Judson Worthington.
A	Hastings, Robert Worthington.
A	Hatch, Anselm Dimmic.
D	Hatch, Edward Sparhawk.
D	Hatch, George Stephen.
D	Hatch, Leonard Francis.
A	Hatchett, William Josephus.
E	Hatfield, Hugh Kerr.
A	Hathaway, Clarence Lockwood.
D	Hathaway, George Stimson.
D	Hathaway, John Gael.
B	Hathaway, Marcus Morton.
A	Hathaway, Sarah Lewis.
A	Hathaway, William Fales.
A	Haub, Augustine Catherine.
D	Haviland, Nathaniel Clark Bacon.
D	Haviland, Walter Childs.
D	Hawes, Alfred Taylor.
A	Hawes, Edward Everett.
D	Hawes, John Bromham, 2d.
A	Hawes, Joseph Quinnum.
E	Hawkes, Charles Eleazer.
D	Hawkins, Henry.
B	Hawkins, Horatio Gates.
A	Hawks, Alfred Joseph.
A	Hawks, Esther Hill.
A	Hay, Gustavus.
D	Hay, Joseph Smyser.
D	Hayden, Lewis Brooks.
A	Hayes, Albert Hamilton.
D	Hayes, Blanche Adelyn.
D	Hayes, David Patrick.
D	Hayes, Frederick Legro.
A	Hayes, Irving Benjamin.
B	Hayes, John Joseph.
D	Hayes, Justin Edward.
A	Hayes, Justin Gideon.
A	Hayes, Stephen William.
D	Hayes, Wentworth Larrabee.
D	Hayford, Herbert Scott.
A	Haynes, Charles Frederick.
D	Haynes, Mabel Stevens.
D	Hayward, Abner.
A	Hayward, Joseph Warren.
D	Hayward, Walter Barrows.
D	Hayward, William Frank.
C	Hayward, George Griswold.
A	Haywood, George William.
A	Haywood, Isabel Pridham.
A	Hazard, George Stevens.
A	Hazelton, Isaac Hills.
D	Hazen, Robert.
D	Hazlett, Olive Binkley.
D	Heald, Charles Gerry.
A	Heald, Joseph Berthelet.
A	Heald, William Frederick.
D	Healy, Daniel Laurence.
D	Healy, John Aloysius.
D	Healy, Thomas Raymond.
A	Heard, John Theodore.
E	Heard, Mary Ann.
D	Hearn, Walter Lawrence.
B	Heath, Abbie Knowlton Marden.
D	Heath, Edward Allen.
A	Heath, Joseph Webster.
D	Heath, Newton Emmer.
D	Heaton, Thomas Henry.
A	Hebbard, Ellery Cola.
A	Hebbert, Charles Alfred.
D	Hébert, Georges.
A	Hedenberg, James.
D	Hedin, Carl Johan.
A	Heffern, Patrick William.
D	Heffernan, David Aloysius.
A	Heigham, Jabez William.
D	Hemeon, Frederick Chipman.
D	Hendee, Leslie Horatio.
A	Henderson, Charles Russell.
D	Henderson, George Dallas.
D	Henderson, Lawrence Joseph.
A	Henderson, Pinckney Marion.
A	Hendrickson, Charles Damariu.
D	Henin, Chaim Chaimor.
A	Henlon, John Briggs.
B	Henotte, Constant.
A	Henry, John Goodrich.
E	Herbert, Edward.
D	Herman, Edwards Woodbridge.
A	Herrick, Edward Barton.
A	Herrick, Joseph Thomas.
E	Herrick, Timothy George.
D	Herrick, Van Buren.
A	Hersey, Freeman Clark.
D	Hess, Peter William.
A	Hetherington, Gilbert Edwin.
C	Hewes, Henry Fox.
A	Hewins, Parke Woodbury.
D	Hewitt, Clarence Elbert.
D	Hewitt, William Oakes.
D	Hews, India Cochel.
A	Hichborn, Herman Granville.
A	Hickey, Garrett Joseph.
D	Hickey, James Eloi.
D	Hickey, John Aloysius.
D	Hickey, John Joseph.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Hickey, Lawrence Joseph.
D Hicks, Charles Andrew.
D Hicks, Elias Peter.
A Hicks, Joseph.
A Hidden, Charles Walter.
A Higbee, Edwin Wilbur.
A Higgins, Frank Albert.
D Higgins, Harry Eugene.
A Higgins, Henry Rich.
A Higgins, James Hayden.
B Higgins, John Henry.
B Higginson, Ella Aurilla.
A Hildreth, John Lewis.
A Hill, Almon Ward.
B Hill, Calvin Augustus.
D Hill, Edgar Dwight.
D Hill, Ernest Linwood.
D Hill, Eugene Woodbury.
C Hill, George Hillard.
D Hill, George Jackson.
D Hill, George Sumner.
D Hill, Ira Clark.
A Hill, Ira Joseph.
A Hill, Lucy Chaloner.
B Hill, Mary Janerson.
A Hill, Noble Hind.
D Hill, Thomas Chittenden.
D Hillard, James Pearse.
D Hills, Charles Everett.
A Hills, Frederick Lyman.
A Hills, William Barker.
A Hills, William Henry.
A Hilton, George Whitefield.
D Hilton, John Daniel.
B Hiltpold, Jacob.
D Hinchcliffe, Harry Palmer.
D Hinchey, Richard.
D Hinckley, James William.
A Hincks, William Sylvanus.
A Hines, Archelaus Don.
A Hines, Isaac Bright.
D Hinson, Jacob Miller.
A Hipkiss, George.
D Hirchler, Rose.
A Hitchcock, Alfred Owen.
A Hitchcock, Edward Bigelow.
A Hitchcock, George Goodwin.
A Hitchcock, Henry Russell.
A Hitchcock, John Sawyer.
A Hitchcock, Walter Samuel Deane.
D Hitchcock, William Alvan, Jr.
E Hixon, Edwin Colfax.
A Hoadley, Alfred Henry.
D Hobart, Austin Walter.
A Hobart, Mary Forrester.
D Hobbie, John Remington.
A Hobbs, Ezra Allen.
D Hoch, Charles August.
A Hodgdon, Andrew Hall.
D Hodgdon, Frank Amasa.
D Hodgdon, Luther Albion.
D Hodgdon, Ralph Franklin.
B Hodge, Dwight Munson.
A Hodges, Almon Danforth.
E Hodges, Stoughton Fletcher.
A Hodgson, Mary Cobb.
A Hodgson, Richard.
A Hodgson, Thomas Smithson.
A Hodskins, Edward Bryant.
D Hodskins, Morgan Brewster.
D Hoey, Warren Henry.
A Hoffman, Gustavus Adolphus.
D Hoffses, Granville Ernest.
A Hogan, Fremont Lincoln.
D Hogan, Joseph Ambrose.
A Hogner, Per Gustaf Richard.
A Hoitt, Eugene Gorham.
D Holbrook, Bradbury.
A Holbrook, George.
A Holbrook, Guy.
B Holbrook, Joseph Edgar.
A Holbrook, Levi Bradford.
A Holbrook, Silas Pinckney.
B Holbrook, Solomon Harding.
D Holbrook, Vernon Dayton.
A Holbrook, William Edward.
A Holcombe, Charles Clifford.
A Holden, Austin.
A Holden, Charles Sumner.
D Holden, Clarence Parnell.
D Holden, Cora Millet.
A Holden, Eugene Martin.
D Holden, George Walter.
A Holden, Leonard Preston.
E Holden, Nebuther.
A Holden, William Daniel.
B Holland, Allen Joseph.
D Holland, Hubert Thomas.
A Holland, James William.
D Holland, Robert Ambrose.
D Holland, William Joseph.
D Holland, William Timothy.
D Hollister, Robert Russell.
D Holmberg, Carl Lester Magnus.
A Holmes, Alvin Dennett.
E Holmes, Arthur Brewster.
D Holmes, Benjamin Henry.
D Holmes, Daniel Henry.
E Holmes, Edgar Miller.
A Holmes, Harry Bigelow.
D Holmes, Harry Clinton.
A Holmes, Horace Marshall.
D Holmes, Howard Fowler.
D Holmes, Le Verne.
D Holmes, Louise Dodson.
D Holmes, Luke Melvin.
B Holmes, Lydia Maria.
D Holmes, May Salona.
D Holmes, William Franklin.
A Holmquist, Gustavus.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Holohan, Patrick Athanasius.
D Holt, Clifford Parker.
D Holt, Edward Wells Atwood.
D Holt, Frank Hammett.
D Holton, Charles Edward.
A Holyoke, Frank.
D Holzman, Joseph.
E Homan, John Milton.
D Homans, John.
A Homer, John.
D Hood, Mary Gould.
A Hooker, Charles Parker.
A Hooker, Edward Dwight.
D Hooker, Stuart Van Rensselaer.
D Hoole, John Edward.
A Hooper, Everett Dennison.
A Hooper, Frederick Hubbard.
A Hooper, Harriett Pervier.
E Holt, Harry Frye.
D Hopkins, Bertrand Hiram.
D Hopkins, Frank Henry.
D Hopkins, Frederick Eugene.
D Hopkins, Henry Wade.
A Hopkins, Samuel Augustus.
A Hopkins, Stephen Worcester.
A Hopkins, William Thorpe.
A Horgan, John Augustus.
D Hornbrook, Frank Wheeler.
F Horne, James Metcalfe.
E Horne, Lester Wallace.
D Horner, Harriet.
A Hornly, Mary Stamper.
A Horr, Albert Winslow.
D Horton, Emma Luella.
D Horton, Herbert Bradford.
D Hoskins, Bertha Ladd.
D Hosley, Walter Alexis.
A Hosmer, Charles Edward.
A Hough, Garry de Neuville.
A Houghton, Henry Lincoln.
A Houghton, Niedhord Hahnemann.
A Houghton, Silas Arnold.
A Houghton, Simon Willard.
A Houle, Anselme Ephrem.
A Houle, Joseph.
A Houston, John Alexander.
D Hovey, Robert Ferry.
C Howard, Alonzo Gale.
A Howard, Amasa.
A Howard, Arthur Chadwick.
D Howard, Charles James.
D Howard, Charles Tilden.
D Howard, Eugene Henry.
D Howard, Frederic Hollis.
A Howard, George Canning.
A Howard, Herbert Burr.
D Howard, Joseph Francis.
A Howard, Margaret Emily Pagelsen.
D Howard, Perez Briggs.
A Howe, Elsie Brewster.
A Howe, Francis Augustine.
A Howe, George Joseph.
D Howe, George Plummer.
D Howe, Harry Newell.
A Howe, James Sullivan.
D Howe, Joseph Dimock.
D Howe, Martha Annie.
A Howe, Octavius Thorndike.
A Howe, Oliver Hunt.
D Howe, Walter Clarke.
E Howe, Winfred Lewis.
B Howell, Ella Virginia.
D Howell, Harry Warfield.
D Howell, Thomas.
D Howell, William Wescott.
A Howes, Clarence Linden.
A Howes, Pitts Edwin.
A Howland, Barker Cushman.
D Howland, Clarence Eugene.
D Howland, Edgar Joseph.
D Howland, Joseph Briggs.
D Howlett, Thomas.
D Hoyt, Dixie George.
A Hoyt, Edward Malcolm.
A Hoyt, Walter Scott.
D Huard, Joseph Edouard.
A Hubbard, Charles Thacher.
A Hubbard, Frank Allen.
A Hubbard, George William.
D Hubbard, Joshua Clapp.
A Hubbard, Josiah Clark.
A Hubbard, Osmon Huntley.
A Hubbard, Rufus Peabody.
A Hubbard, Simeon Pease.
A Hubbard, William Allen.
A Hubbell, Adelbert Merton.
E Huckins, Theron Howard.
A Hudnut, Frank Parker.
D Hudnut, Paul Albert.
E Hudson. Arthur Stanton.
D Hudson, Wendell Phillips.
D Huehne, Julius.
D Hughes, George Frederick, Jr.
C Hughes, Laura Ann Cleophas.
D Hughes, Patrick James.
D Hughes, Rudolph Emmet.
A Hull, Ernest Liverus.
A Hull, John Byron.
A Hull, William Henry.
A Hulme, Laura Payne.
B Hulse, Lester Addison.
B Humes, Albert Henry.
A Hunking, Charles Dustin.
D Hunt, Alice Elizabeth Palmer.
A Hunt, Allston Frost.
A Hunt, Charles Richard.
A Hunt, Daniel Lawrence.
A Hunt, David.
D Hunt, Ernest Leroi.
A Hunt, George.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Hunt, George Eddy.
D	Hunt, George Pratt.
A	Hunt, Israel Thorndike.
A	Hunt, John Abram.
A	Hunt, Lemuel Judson.
C	Hunt, Otis Eugene.
F	Hunt, Simeon.
A	Hunt, William Eustis.
D	Hunt, William West.
A	Hunt, William Otis.
D	Hunt, Wilson Eugene.
D	Hunter, Edwin Norman McLeod.
D	Hunter, Henry John.
A	Hunting, Nathaniel Stevens.
D	Huntington, Thomas Marshall.
A	Huntoon, Hazen Prescott.
A	Huntress, Leonard.
D	Hurd, Albert Gordon.
A	Hurd, Alonzo L.
A	Hurd, George Platt.
D	Hurd, Randolph Campbell.
A	Hurd, William Weymouth.
C	Hurley, Daniel Bartholomew.
A	Hurley, Daniel Madison.
D	Hurley, Edward Daniel.
D	Hurley, James Edward.
E	Hurley, John Joseph.
D	Hurley, Patrick Eugene.
A	Hurtubise, Louis Francis Athagnase.
D	Hurwitz, Abraham Joseph.
C	Huse, George Wood.
D	Hussey, Charles Bumps.
E	Hussey, Edward John.
A	Husted, Louise Akerly.
B	Hutchings, Charles William.
A	Hutchings, Joseph Henry.
A	Hutchings, George Henry.
D	Hutchins, Guy Howard.
D	Hutchins, Henry Talbot.
A	Hutchinson, Charles Martin.
A	Hutchinson, Chessman Palmer.
A	Hutchinson, Claribel Merrill.
A	Hutchinson, Edwin Darius.
A	Hutchinson, Marcello.
B	Hutchinson, Nelson Vinal.
D	Hutchinson, Walter Perkins.
D	Huyck, Clifford John.
D	Hyatt, Harry William.
D	Hyde, Frederick Tanquary.
A	Hyde, George Smith.
D	Hyde, James Samuel.
D	Ide, Henry Clay, 2d.
D	Ide, Philip Sheridan.
A	Ilsley, Frederick Roscoe.
A	Inches, Charles Edward.
A	Ingalls, George Hancock.
D	Ingham, Lucius Thomas.
D	Inglis, Harry James.
E	Ingoldsby, Joseph Emmanuel.
A	Ingraham, Lena Vaughn.
A	Ingram, Mary Petronella de Booij.
D	Ireland, Frederick William.
A	Irish, John Carroll.
A	Irvine, William Herbert.
D	Irving, John James.
D	Irwin, Vincent Joseph.
A	Jack, Edwin Everett.
A	Jack, Ernest Sanford.
A	Jack, Frederick Lafayette.
D	Jack, Lewis Harlow.
A	Jack, Robert.
D	Jackman, Alice May.
D	Jackson, Alexander Washington.
C	Jackson, Alton Atwell.
A	Jackson, Amos Messer.
A	Jackson, Charles William.
A	Jackson, Cornelius Sampson.
D	Jackson, Fred Kinney.
A	Jackson, Fred William.
D	Jackson, George Henry.
E	Jackson, Gertrude Pearson.
A	Jackson, Henry.
D	Jackson, Howard Bigelow.
A	Jackson, James Marsh.
A	Jackson, John Henry.
D	Jackson, John Patrick.
D	Jackson, Oliver Howard.
D	Jackson, Osceola E.
A	Jackson, Ralph Wentworth.
A	Jackson, Samuel Hahnemann.
D	Jackson, William Andrew, Jr.
A	Jackson, William Benjamin.
A	Jackson, William Leavitt.
E	Jacobs, Charles Michael.
D	Jacques, Joseph Alexander Dambourges.
D	Jacques, Louis Désire Onesiphore.
A	Jacques, Napoleon.
A	Jaffe, James Arthur.
A	James, Frances Celicia.
D	James, Howard.
D	James, Joseph Francis.
D	James, Lucille Amanda.
B	James, Woodbury Dyer.
B	Jameson, Robert Edwin.
E	Janes, Arthur Percy.
A	Janes, George Herbert.
D	Janeway, Henry Harrington.
A	Janson-La-Palme, Rodolphe Gaspard.
A	Jaques, Henry Percy.
A	Jarvis, William Furness.
D	Jeffers, Edward.
A	Jefferson, Herbert Perry.
D	Jefferson, Willis Grover.
A	Jeffries, Benjamin Joy.
D	Jelalian, Hairabed S.
B	Jelen, Henry.
A	Jelenkiewicz, Jacob.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Jelly, Arthur Carlton.
A Jelly, George Frederick.
A Jenckes, Joseph Franklin.
B Jenkins, Charles Dunsford.
A Jenkins, Charles Edwin.
A Jenkins, George Oscar.
E Jenkins, Gladstone Lawson.
A Jenkins, Thomas Lincoln.
A Jenks, Harrison Darling.
D Jenness, Burt Franklin.
A Jenness, Sarah Abbie.
A Jenney, Arthur Barker.
D Jennings, Curtis Herman.
D Jennings, Robert.
A Jernegan, Holmes Mayhew.
D Jernegan, Walter Stewart.
A Jewett, Fred Bryce.
A Jewett, Frederick Augustus.
A Jewett, Howard Clifton.
C Jewett, Walter Kendall.
A Jillson, Franklin Campbell.
A Johnson, Charles Frederic.
D Johnson, Charles Kimball.
B Johnson, Charles Lemuel.
D Johnson, David Joseph.
A Johnson, Edward Stearns.
C Johnson, Elmore Reuben.
E Johnson, Erik St. John.
A Johnson, Francis Emerson.
C Johnson, Frank Mackie.
A Johnson, Frederick William.
D Johnson, George Anson.
D Johnson, Grahame Dove.
E Johnson, Granville Roswell.
D Johnson, Harold Abbott.
D Johnson, Herbert Shattuck.
A Johnson, John Gore.
D Johnson, John Herbert.
A Johnson, John Waldo.
A Johnson, Orville Edson.
D Johnson, Peer Prescott.
A Johnson, Sara.
A Johnson, Stephen Joseph.
D Johnson, Walter Sydney.
A Johnson, William Augustus.
A Johnson, William Louis.
D Johnston, Reuben Thomas.
D Johnston, William.
A Johnstone, William Joseph.
D Jones, Arthur Willis.
A Jones, Charles David.
A Jones, Claude Perry.
D Jones, Daniel Fiske.
A Jones, Daniel Wayland.
A Jones, Elbert Archer.
A Jones, Elgin Wilbur.
A Jones, Ellis Preston.
D Jones, Everett.
E Jones, Francis Joseph.
D Jones, Frederick Ellis.
D Jones, Frederick Elmer.
A Jones, George Howard.
A Jones, George Warren.
A Jones, Gilbert Norris.
D Jones, Harold Wellington.
D Jones, James Arthur.
A Jones, John Clark.
B Jones, John Paul.
D Jones, John Thomas Paul.
A Jones, Joseph.
A Jones, Lombard Carter.
A Jones, Lyman Asa.
A Jones, Mary Elizabeth.
D Jones, Mary Scott.
D Jones, Raymond Child.
D Jones, Seth Warner.
A Jones, Sophia Carlton.
D Jones, Wellington West.
A Jones, William Marks.
A Jordan, Charles.
A Jordan, Charles Harold.
D Jordan, Ernest Major.
A Jordan, George Albert.
A Jordan, Henry Jacob.
D Jordan, John Franklin.
D Jordan, William Henry.
C Joslin, Elliott Proctor.
D Joslin, Perry Edward.
D Joslin, Samuel Lees.
A Josselyn, Eli Edwards.
D Jouett, Fred Robert.
E Journeay, Warren William.
A Joyce, Charles Pitt Fld.
D Joyce, James Henry.
A Joyce, Thomas Francis.
A Judah, Lucian Alexander.
A Judd, David Hiram.
E Judge, Albert Augustine.
B Judge, James Daniel.
D Judkins, Anna Gertrude.
A Judkins, Frank Luvelle.
D Junkins, Helen McDuffee.
A Kaan, George Warton.
A Kahn, Alexander.
D Kahn, Paul.
D Kahn, Wulf.
D Kalousdian, Nazareth Manoug.
A Kane, John Henry.
D Kapp, Julia Seaton.
A Karner, Edwin Belden.
D Katsainos, George Michel.
D Kazanjian, Hampar Baghoss.
A Kean, Louise Janett Darnstaedt.
D Keaney, Henry Joseph.
C Keany, Francis Joseph.
E Kearney, John Henry.
E Keate, Walter.
A Keating, James Edward.
D Keay, Harry Chester.
D Keck, Charles Erhard.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Keefe, Daniel Edward.
A	Keefe, Patrick Henry.
A	Keegan, Charles Andrew.
A	Keegan, Vincent Elijah.
D	Keeler, William Basil.
A	Keenan, Herbert John.
D	Keene, Charles Herbert.
A	Keep, Charles Manning.
A	Keife, Carolyn Ignasce.
A	Keir, Erskine Johnston.
D	Keisker, Laura.
D	Keith, Avis Muna.
A	Keith, Ellen Louisa.
A	Keith, Frederick Scott.
A	Keith, George Wallace.
D	Keith, Halbert Lynn.
A	Keith, Wallace Cushing.
A	Keleher, Francis Joseph.
A	Keleher, William Henry.
D	Kelleher, Patrick Francis.
A	Keller, Elizabeth Catherine.
D	Keller, William Johnson.
E	Kelley, Daniel Joseph.
A	Kelley, Horatio Sprague, Jr.
D	Kelley, John Thomas.
A	Kelley, Joseph Henry.
D	Kelley, Joseph Henry Hart.
A	Kelley, Michael Joseph.
A	Kelley, Seth Wight.
E	Kelley, Walter Henry.
D	Kelliher, Mayville Sumpter.
A	Kelliher, Michael William.
A	Kellogg, Edward Brinley.
E	Kellogg, Emery Campbell.
A	Kellogg, Frederic Leroy.
D	Kelly, John Joseph.
A	Kelly, Michael.
A	Kelly, Samuel James.
D	Kelly, Thomas Francis.
D	Kelly, William Dugan.
A	Kelly, William P.
A	Kelsey, Otis Hiland.
A	Kemp, Edwin Augustine.
C	Kennard, Harry Delano.
D	Kenealy, Joseph Henry.
A	Kennealy, John Henry.
D	Kennelly, Julia Grice.
A	Kennedy, Alexander Edward.
D	Kennedy, Alexander G.
A	Kennedy, Alonzo Lewis.
A	Kennedy, Catherine Moloney.
A	Kennedy, Charles Francis Joseph.
D	Kennedy, Eugene Augustine.
A	Kennedy, Frederick William.
A	Kennedy, George Golding.
D	Kennedy, Harris.
A	Kennedy, James Simon.
D	Kennedy, Michael Colville.
D	Kennedy, Thomas Francis.
B	Kennedy, Thomas Patrick.
A	Kenney, Franklin Woodbury.
D	Kenney, Hattie Eliza.
D	Kenney, John Erle.
D	Kenniston, William Beaman.
D	Kennon, Charles Edward de Ven.
D	Kent, Bradford.
B	Kent, Daniel Hurley.
D	Kent, Ralph Porter.
A	Kenyon, Henry Jesse.
A	Keown, James Archibald.
D	Kepler, Charles Ober.
D	Kernan, William Everett.
D	Kerr, Isabella Dickieson.
D	Kerrigan, James Thomas.
D	Kershner, Warren Edglie.
D	Kidner, Frederick Clinton.
D	Kilbourn, Arthur Goss.
A	Kilburn, Henry Whitman.
A	Kilby, Henry Sherman.
A	Kiley, Edward Stephen.
F	Kilgore, George Liberty.
E	Killory, George Leo.
A	Kilroy, Philip.
D	Kimball, Alice Lavinia.
D	Kimball, James Henry.
A	Kimball, Joseph Edwin.
A	Kimball, Leonard Morong.
A	Kimball, Levi Houghton.
A	Kimball, Samuel Ayer.
A	Kimball, William George.
A	Kimpton, Edwin Sewell.
A	King, Calvin Bryant.
B	King, Charles Duncan.
C	King, Frederick Augustine.
D	King, Hamilton Theodore.
D	King, Henry Daniel.
D	King, Howard Frost.
D	King, James Aldrich.
D	King, Jesse.
D	King, John William.
D	King, Maxwell Benedict.
D	King, Myron Louis.
A	King, Nathaniel Clark.
D	King, Sarah Ella.
C	King, William Rufus.
A	Kingman, James Henry.
A	Kingman, Rufus Anderson.
A	Kingsbury, Albert Dexter.
A	Kingsbury, Charles Franklin.
E	Kingsbury, Charles Henry.
A	Kingsbury, Joseph Byron.
A	Kingsbury, Charles Langdon.
A	Kingsley, Charles.
D	Kingsley, Patrick Joseph.
D	Kinlin, Terrance Thomas.
D	Kinloch, Raymond Alexander.
A	Kinne, George Lyman.
A	Kinney, Eunice Draper.
A	Kinney, John Edgar.
D	Kinney, William D'Arcy.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Kinnier, Denis Francis.
E Kinsley, Cephas Daniel.
D Kinsman, Henry Francis.
D Kirby, Francis Joseph.
D Kirby, Frank Alonzo.
D Kirby, Holder Crary.
D Kirby, James Richard.
D Kirby, Nathaniel Harris.
A Kirby, Thomas Edward.
A Kirk, Lucy Anne.
D Kirshner, Adelaide Rosalind.
D Kite, Walter Chester.
A Kittredge, Joseph.
A Kittredge, Thomas.
A Klein, August Andreas.
A Klemmer, Denis Francis.
A Klemmer, Wilhelm Nickolaus.
D Klopp, Henry Irwin.
A Kludjian, Assadour Hagot.
A Knapp, Philip Coombs, Jr.
D Kneeland, Wellington Edward.
E Knickerbocker, Percy Gates.
A Knight, Augustus Smith.
D Knight, Charles Eugene.
E Knight, Charles Lewis.
D Knight, Charles Storer.
A Knight, Charles Sumner.
D Knight, Edwin Augustus.
E Knight, Frank Henry.
A Knight, Frederick Irving.
A Knight, Granville.
A Knight, Henry Sargent.
D Knight, Howard Webster.
A Knight, Joseph Noble.
A Knight, Marcus Whitney.
B Knight, William Henry Anderson.
A Knowles, James Harris.
E Knowles, Robert Keneborough Black.
A Knowles, William Fletcher.
A Knowles, William Kelley.
A Knowlton, Charles Davison.
A Knowlton, Herbert Eugene.
D Knowlton, John Greenleaf Whittier.
A Knowlton, Wallace Mills.
D Knowlton, William Thomas.
D Koch, James Lafayette.
B Kohan, Alexander.
D Konikow, Antonia Frederica.
A Konikow, Moses Joseph.
D Koplowitz, Abraham.
A Krauss, James.
B Kronberger, Israel Baruch.
D Krum, Frank Wilson.
D Kurth, Gustave Emil.
D La Belle, Martin James.
D Labelle, Urgele.
E Lacaillade, James Oliver.
D Lachance, Alfred Phileas.
E Ladd, Fred Eugene.
D Ladd, Joseph Howard.
D Ladd, Maynard.
D Ladd, Samuel Tilden.
D La Fleur, Fred Joseph.
D Lafontaine, Gustave.
A Laforce, Edward Dontial.
B L'African, Eugéne.
D Lahey, Francis Howard.
A Laidley, John Baine.
D Laighton, Florence Marion.
D Laird, Arthur Turner.
A Lake, Hiram.
D Lake, John, Jr.
C Lakeman, Mary Ropes.
D Lally, Francis Henry.
D Lamagna, Domenico.
E Lamaire, Willard Wallace.
D Lamarche, George Tancrède.
A La Marche, Walter Joseph.
A Lamb, Colby.
A Lamb, Frances Gertrude.
D Lamb, William Dan.
D Lambert, Fred De Forest.
D Lambert, John Henry.
D La Motte, Xavier Alexander.
A Lamoureaux, Joseph Elzéar.
A Lamson, John Augustus.
D Lamson, Theodore.
D Lancaster, Alston Howard.
A Lancaster, Sherman Russell.
A Lancaster, Walter Brackett.
B Lande, Abraham Joseph.
D Landers, Garrett John.
D Landers, Morris Bernard.
D Landers, Maurice Joseph.
B Landis, Lillian Etta.
D Landry, Joseph Napoleon.
D Landry, Louis Henry.
A Landry, Napoleon.
A Lane, Albert Clarence.
A Lane, Charles Franklin.
A Lane, Edward Binney.
A Lane, Francis Augustus.
D Lane, Frank Ellsworth.
B Lane, Ida Ella Hale.
A Lane, John Goodwin.
A Lane, Orville Wilbur.
A Lane, Robert Low.
D Lane, Walter Appleton.
B Lane, William Colton.
D Lang, Herbert Bowman.
D Langan, John Thomas.
A Langevin, Joseph Alphonse.
A Langlois, Joseph Augustin.
D Langlois, William Edward.
A Langmaid, Samuel Wood.
D Langworthy, Henry Glover.
D Lambert, John Francis.
D Lamphear, Charles Howard.
B Lanman, Charles Henry.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Lanoie, Joseph Eusibe Eugene
D	Lanone, Alphonse.
D	Lapham, George Nelson.
A	Large, Alfred.
B	Larkeque, Garret Bancroft Breckinbridge.
D	Larrabee, Herbert Manson.
D	Larrabee, Ralph Clinton.
E	Latham, Benoni Mowry.
A	Latham, Caroline Augusta.
A	Lathe, Leonora Fletcher.
A	Lathrop, William Henry.
A	Latter, Leonard.
D	Latterner, Frederick Henry.
B	Laurence, David.
D	Laurin, Theophilus.
D	Laurion, Adelard.
D	Lavellee, George Omer.
D	La Vigne, Alfred Willis.
D	Lavoie, Joseph Paradis.
A	Lawler, Thomas Joseph.
A	Lawler, William Patrick.
D	Lawlor, James Francis.
D	Lawlor, John Joseph.
D	Lawlor, Richard Henry.
D	Lawrence, Arthur Abbott.
D	Lawrence, James Chrisby Hurd.
D	Lawrence, James Wilmot.
A	Lawrence, Joseph Henry.
D	Lawrence, Nellie Louise.
D	Lawrence, William Ethan.
D	Laws, Sophie Goudge.
A	Lawson, Frederick Bartlett.
D	Lazarus, Benjamin.
A	Leach, Albert Clinton.
A	Leach, Clara Celestia Austin.
A	Leach, Edward Morton.
A	Leach, Horace Morton.
E	Leahey, Frederick Andrew.
A	Leahey, George Henry Aloysius.
E	Leahy, James Percival.
A	Leahy, Thomas Joseph.
A	Leard, John Samuel Hick.
B	Learned, Noyes Newton.
A	Learned, John Barr.
A	Learned, William Turell.
A	Learoyd, Charles Berry.
D	Leary, Adelaide Olga Cushing.
D	Leary, Chrysostom John.
A	Leary, James Edward.
A	Leary, John Henry.
A	Leary, Patrick Frank.
C	Leary, Timothy.
D	Leary, William Charles.
D	Leary, William Cornelius.
A	Leavitt, Dudley.
D	Leavitt, Edwin Alden.
D	Leavitt, Frank Clyde.
D	Leavitt, Forrest.
D	Leavitt, Mary Augusta.
A	Leavitt, William Whipple.
D	Le Bel, Timothée.
A	Leblanc, Aimé Noël.
D	Le Blanc, Clement Oliver.
A	Le Boeuf, Joseph Sylva.
D	Lecompte, Walter Augustus.
A	Lee, Frank Herbert.
E	Lee, Henry Jason.
A	Lee, Luther Milo.
E	Lee, Ralph Everett.
D	Lee, Wesley Terence.
D	Lee, William George.
A	Leeds, Charles.
D	Leen, Thomas Francis.
D	Legg, Arthur Thornton.
A	Lehmann, Anthony.
D	Leib, Edwin Roy.
A	Leib, Thomas Nuttall.
B	Leighton, Harry Burbank.
A	Leitch, John Alvin.
A	Le Lacheur, Ellis Sweetlove.
A	Leland, Clarence Henry.
A	Leland, George Adams.
D	Lemaire, William Franklin.
A	Le Maitre, Joseph Michel.
D	Lemieux, Théodule Alfred.
E	Lentine, Gaspare Emmanuel.
D	Leonard, Edwin, Jr.
D	Leonard, Henry Fiske.
A	Leonard, Henry Patrick.
E	Leonard, Isaac Edward.
D	Leonard, John Michael.
A	Leonard, Milton Hall.
D	Leonard, William Joseph.
E	Lepper, David Barnard.
A	Lescadre, Henry.
A	Leslie, Freeland David.
E	Leslie, Herbert Granville.
A	Leslie, Horace Granville.
D	Levasseur, Augustus Joseph Hugo.
B	Levenson, Sophia.
D	Leverton, Charles Henry.
A	Levey, George.
E	Levins, Nathan Noah.
D	Levis, Harold James.
D	Levy, Felix Julius.
D	Lewandowski, Joseph.
B	Lewis, Andrew Valentine.
A	Lewis, Arthur Cuthbert.
D	Lewis, Edwin Ray.
E	Lewis, Elisha Sears.
D	Lewis, Frederic Thomas.
C	Lewis, George Fred.
D	Lewis, James Prince, Jr.
A	Lewis, John Taylor.
D	Lewis, Marion.
C	Lewis, Marion Hall.
B	Lewis, Millard Edrie.
D	Lewis, Seth Ames.
B	Lewis, William Edmund.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Libbey, Charles Emerson.
A Libby, Charles Adelbert.
D Libby, Edward Norton.
A Libby, Jesse Herbert.
D Libby, Mary Gordon.
D Libby, Mildred Augusta.
A Lighthill, August Ponham.
D Lilienthal, Alice.
B Lilley, William.
E Lilly, Albert Henry.
E Lilly, Thomas Eugene.
A Lincoln, Guy Alvan Thorndike.
A Lincoln, Jacob Read.
D Lincoln, Merrick.
E Lindquist, Carl Augustus.
D Lindsay, Joseph Ira.
D Lindsey, John Hathaway.
A Lindsey, Joseph Ferdinand, Jr.
D Linenthal, Harry.
A Linfield, Edwin Porter.
A Litch, John Goodrich.
C Litchfield, William Harvey.
D Lithgow, Robert Alexander Douglas.
A Littell, Alice.
D Little, Abby Noyes.
D Little, Charles Sherman.
E Little, George Thomas.
A Little, Harry James.
D Little, John Mason, Jr.
A Little, William Brimblecom.
D Littlefield, Anna Maria.
D Littlefield, George Curtis.
D Littlefield, George Henry.
A Littlefield, Samuel Horace.
B Liverpool, Joshua Henry.
D Livingston, Clarence Bertram.
D Livingston, Ernest George.
D Livingston, Isabel.
A Livingston, Joseph Alexander.
A Lloyd, Charles.
B Lloyd, Seth Louis.
D Lobo, José Paulo Filomeno Piedade Martinho.
D Lockary, Joseph Logue.
D Locke, Edwin Allen.
A Locke, Horace Mann.
A Lockhart, Joseph Smith.
D Lockwood, Charles Edwin.
D Lockwood, George Bertrand.
E Loewe, Leonard Joseph.
D Loftus, John Thomas.
D Logan, Frank Parker Tays.
E Login, Louis.
A Lombard, John Patrick.
C Lombard, Julia Mary.
D Long, Margaret.
D Longfellow, Henry Nathan.
B Longfellow, Melvina Frances.
A Longley, Mary Theresa.
A Loomis, Charles Otis.
D Loomis, Julius Sterling.
A Loomis, William Wellington.
D Lootz, Emma.
D Lord, Frederic Pomeroy.
D Lord, Frederick Taylor.
D Lord, Herbert.
A Lord, Sidney Archer.
D Lord, William Ogden.
D Loring, Benjamin Tappan.
A Loring, Harriet Augusta.
D Loring, Robert Gardiner.
A Loring, Robert Pearmain.
A Lortie, Joseph Charles Hormisdas.
A Lothrop, Charles Arthur.
A Lothrop, George Edgar.
A Lothrop, Howard Augustus.
D Lothrop, Percy.
B Loucks, John Stearns.
D Lougee, Arthur Jewett.
A Lougee, Frank Taylor.
A Lougee, May Williamina.
D Lougee, William Wheeler.
B Lougest, Charles Albert.
D Loughlin, John Joseph.
D Loughran, James Francis.
A Louis, Isaac.
D Love, James.
D Love, William Lathrop.
A Lovejoy, Charles Averill.
D Lovejoy, Fred Wendell.
A Loveland, Charles Harrison.
A Lovell, Charles Dixon Smith.
A Lovell, Charles Edward.
A Lovell, David Bigelow.
B Lovell, Gideon.
D Lovell, Harriet Jane.
D Lovell, Lucinda Sarah.
D Lovell, Martha Eleanor.
A Lovering, Anna Temple.
A Lovett, Robert Williamson.
D Low, Harry Chamberlain.
D Lowd, Harry Mosher.
D Lowe, Ernest Whittier.
C Lowe, Fred Messenger.
D Lowell, Albert Fay.
D Lowell, Alverne Percy.
D Lowell, Freeman Lamprey.
D Lowell, Hannah.
D Lowell, William Hornbrook.
D Lowenstein, Frederick Philip.
D Lowney, Dionysius Joseph.
E Lowney, Jeremiah Joseph.
E Lowney, John Francis.
A Lubin, Leon Thèophile Jules.
D Luce, Dean Sherwood.
A Luchsinger, Harry Warner.
D Luck, Emil Paul Max.
A Ludden, Emerson Augustus.
B Lull, Henry Cushman.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Lund, Fred Bates.
A	Luscombe, Job Everett.
A	Lussier, Charles Arthur.
A	Lussier, Cyrille Francois.
D	Lynch, Charles Francis.
E	Lynch, Cornelius Joseph.
A	Lynch, Michael Henry.
D	Lynch, Patrick Michael.
F	Lynn, Charles William.
A	Lyon, Annie Isabelle.
A	Lyon, Arthur Vinal.
D	Lyon, Frederick Dow.
A	Lyons, Christopher Philip.
A	Lyons, Herbert Henry.
A	Lyons, Joseph Benedict.
A	MacArthur, George Elden.
D	MacCabe, Arthur.
D	MacCallum, Wallace Peter.
D	MacCarthy, Francis Hamilton.
D	MacCormick, John Allan.
D	MacCoy, William Edward.
D	Macdonald, Alexander Ambrose.
A	Macdonald, Angus.
A	MacDonald, Archibald Elexcis.
A	Macdonald, Colin William.
A	Macdonald, Donald Francis.
D	MacDonald, Elmar Joseph.
D	Macdonald, Frederick Corneilius.
A	Macdonald, James.
D	Macdonald, James Stevens.
A	MacDonald, Rufus Cyrene.
D	MacDonald, William Campbell.
D	Macdonald, William Clifford.
A	Macdonald, William Gregory.
A	Macdonald, William Lewis.
A	MacDonnell, John.
A	Macdougall, Duncan.
D	Mace, Charles Herbert.
A	Mace, Herbert Eugene.
D	Macgowan, Joseph Johnston.
C	Mack, Charles David Gibson.
C	Mack, Helen Georginia Flagler.
D	Mackay, Andrew Joseph.
D	Mackay, Edward Hart.
D	MacKay, George Finlay.
A	Mackeen, Alfred Atwater.
A	MacKenzie, Freeman Alexander.
A	Mackie, George.
A	Mackie, Laura Viola Gustin.
A	Mackie, William Basilio.
D	Mackie, William Charles.
D	Mackillop, Daniel.
C	Mackin, Charles.
D	Mackintosh, Ernest Robert.
D	MacLachlan, Thomas Mitchell.
D	Maclean, Emeline Helen.
D	Macleod, Harry Found.
D	Macleod, William Preston.
D	MacMahon, John Joseph.
D	MacMillan, Andrew Louis.
D	MacOdrum, Angus.
D	Macomber, Nathaniel Gifford.
C	Macpherson, George Sturtevant.
A	Macpherson, Frederick William.
D	MacQuaid, John Stephen.
D	Macrae, Annie Campbell.
B	MacRae, Duncan.
D	MacSweeny, Edmund George.
D	MacWhinnie, Arthur Morgan.
D	Macy, Fred Stevens.
E	Madden, John Joseph.
C	Madden, William Daniel.
D	Madison, James Daniel.
A	Magee, Edward Joseph.
A	Magee, John Augustine.
D	Magrath, George Burgess.
D	Maguire, Charles Francis.
C	Maguire, John Edward.
D	Maguire, Thomas Henry.
E	Maguire, Thomas Joseph.
C	Magurn, Francis Thomas Louis.
D	Mahady, Joseph John.
D	Mahady, Stephen Augustus.
D	Mahlman, Robert Mowe.
D	Mahon, James Arthur.
D	Mahoney, Daniel Francis.
D	Mahoney, Edward Joseph.
E	Mahoney, Francis Aloysius.
D	Mahoney, George Clifton.
E	Mahoney, John Lewis.
A	Mahoney, John Stephen.
A	Mahoney, Stephen Andrew.
E	Mahony, Francis Ronan.
A	Maine, Frank Duane.
D	Mains, Charles Frederick.
D	Makechnie, Arthur North.
A	Makechnie, Horace Perkins.
C	Mallory, Frank Burr.
E	Malone, Charles.
D	Malone, John.
D	Maloney, Daniel Arthur.
D	Maloney, Thomas Aloysius.
D	Malonson, James Henry.
A	Manahan, Herbert Wellington.
D	Manahan, Thomas James.
A	Manchester, Delos Burd.
D	Mandell, Augustus Hamlin.
D	Maney, John Joseph.
A	Mangan, John Joseph.
D	Mangan, Patrick Henry.
D	Manix, Edward Tuck.
D	Mann, Arthur Teall.
F	Mann, Augustine Alvan.
D	Mann, Henry Levi.
A	Mann, Martha Elizabeth.
A	Mann, Mary Ella.
A	Mann, Mary Frances.
A	Mann, William Orris.
B	Manseur, Mary Merrill.
A	Mansfield, Charles.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Mansfield, Francis.
A	Mansfield, Henry Tucker.
D	Mansfield, James Albert.
A	Mansfield, John Robbins.
A	Mansfield, Robert Joseph.
E	Mansfield, Walter Ralph.
D	Mansur, Leon Wallace.
A	Mansur, Richard Harrison.
A	Mara, Frank Timothy.
A	Marble, John Oliver.
D	Marcley, Walter John.
D	Marcon, Louis Benjiman.
D	Marcoux, Ephrem Alphonse.
A	Marcy, Henry Orlando.
D	Marcy, Henry Orlando, Jr.
D	Marden, Milmot Leighton.
A	Marin, Joseph Paul Aster.
D	Marin, Raymond.
D	Marino, Luigi.
A	Marion, Horace Eugene.
A	Marion, Otis Humphrey.
D	Markham, Erwin Walter.
D	Marr, Myron Lawrence.
A	Marsh, Albert.
C	Marsh, Arthur White.
A	Marsh, Charles David.
D	Marsh, Frank Filmore.
A	Marsh, James Elmer.
D	Marsh, Lucinda Anne.
D	Marshall, Augustus Thompson.
D	Marshall, Bertrand Frank.
A	Marshall, Carey Fenton.
A	Marshall, Foster Leroy.
D	Marshall, Harold Kenneth.
D	Marshall, Herman Prince.
A	Marshall, Julia Ann.
D	Marshall, Perry.
D	Marstin, Chauncey Macaulley.
D	Marston, Albert Jeremiah.
D	Marston, Daniel William.
A	Marston, Edward Brooks.
B	Marston, George Dexter.
E	Marston, Joseph Norris.
A	Marston, Luther Moulton.
D	Martel, Stanislas.
D	Martin, Archibald Herbert.
A	Martin, Francis Coffin.
A	Martin, George Albert.
A	Martin, George Forrest.
A	Martin, Gregory Arvide.
D	Martin, Harry Charles.
E	Martin, John Brayton.
D	Martin, John Joseph.
D	Martin, John Macleod.
A	Martin, Luther Orin.
A	Martin, Miles.
A	Martin, Pearl.
D	Martin, William John.
D	Marvel, Reuben Joshua.
D	Marvell, Mary Wilbur.
A	Marvin, Grace.
D	Marvin, Sydney Robertson.
A	Maryott, Erastus Edgar.
D	Maskell, Leonard Joseph.
B	Mason, Almond Waldo.
A	Mason, Amos Lawrence.
A	Mason, Atherton Perry.
D	Mason, George.
D	Mason, Gilbert McClellan.
E	Mason, Nathaniel Robert.
E	Massa, Gaetano.
D	Masse, Jean Baptiste.
D	Massé, Mathilde Marie.
D	Masten, Charles Howard.
D	Mastrangelo, Marco.
A	Mather, Edward Elias.
D	Mather, John Adams.
D	Matheson, James Renwick.
D	Mathews, George William.
A	Matte, Joseph Hubert Ambrose.
D	Maxfield, George Henry.
D	Maxwell, George Bannerman.
A	Maxwell, Warren Brown.
E	May, Charles Emerson.
A	May, George Elisha.
D	May, John Shepard.
D	May, William Ropes.
C	Mayberry, Charles Bradford.
A	Mayberry, Edwin Nelson.
D	Mayberry, Frank Eugene.
D	Mayell, Ernest Alfred.
D	Mayers, John Edward.
D	Mayes, Matthew Taylor.
D	Mayhew, Orland Smith.
D	Maynard, Arthur.
D	Maynard, Herbert Ernest.
A	Maynard, Louis Aime.
E	Mayrand, Eugene.
D	McAdams, James Philip.
D	McAdams, Peter Stevens.
D	McAllester, Ralph William.
D	McAllister, Frederick Danforth.
D	McAllister, John Gilman.
D	McAllister, John Joseph Hector.
D	McArdle, John Joseph.
E	McAuslan, James Lewis.
A	McAvinnue, Frank.
D	McAvoy, John Joseph.
D	McBain, William Hearst.
D	McCabe, Denis John.
A	McCabe, John Joseph.
D	McCaffrey, Charles Francis.
A	McCann, Alfred Ernest Arthur.
D	McCarthy, Charles Ambrose.
A	McCarthy, Charles Daniel.
A	McCarthy, Charles Florence.
A	McCarthy, Eugene Allen.
E	McCarthy, Frederick.
D	McCarthy, Henry Thomas.
A	McCarthy, John Coakley.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	McCarthy, Lewis Flurence.
E	McCarthy, Patrick Henry.
D	McCarthy, Timothy Francis.
D	McCarthy, Thomas Francis.
A	McCarthy, Thomas Horatio.
A	McCarthy, William Henry.
A	McCarty, James Joseph.
E	McCauley, Albert Anthony.
D	McCausland, William James.
A	McClean, Alexander Spear.
A	McClean, George Chesley.
A	McClearn, Charles William.
D	McClintock, Francis Blake.
D	McCluskey, Henry Lincoln.
A	McCollester, John Quincy Adams.
A	McCollom, John Hildreth.
A	McConnell, Hugh Beemer.
D	McCooey, John Francis.
A	McCormack, Alexander Leslie.
A	McCormack, Reynold James.
D	McCormick, Alfred Hugh.
A	McCormick, Cornelius Joseph.
E	McCormick, John.
D	McCormick, John Joseph.
D	McCormick, Thomas Joseph Henry.
E	M'Coy, George Madison, Jr.
E	McCoy, Hugh Alexander.
D	McCoy, John Cresap.
A	McCrea, Albert James.
D	McCuen, Charles Nicholas.
D	McCullough, Edward Aloysius.
D	McCurdy, James Huff.
D	McDermott, Bernard Francis.
D	McDermott, Joseph Edward.
D	McDermott, William Vincent.
A	McDevitt, James John.
D	McDonald, Charles Dearborn.
A	McDonald, James Athanasius.
D	McDonald, James William.
A	McDonald, John Henry.
E	McDonald, Joseph.
D	McDonald, Samuel James.
A	McDonald, William Alexander.
D	McDonald, William Joseph.
B	McDonough, Thomas Patrick.
A	McDougall, Samuel Jay.
E	McEvoy, George Albert.
D	McEvoy, Thomas Edward.
D	McFee, William David.
D	McGaffigan, Bernard Francis.
D	McGann, John Henry.
A	McGannon, Thomas Gerald.
D	McGauran, George Daniel.
B	McGauran, George Francis.
A	McGauran, Michael Sheridan.
D	McGee, Fannie Maria.
D	McGillicuddy, Cornelius Joseph.
A	McGillicuddy, John Timothy.
D	McGillicuddy, Richard Aloysius.
D	McGinley, Michael Charles.
D	McGirr, Felix Francis.
D	McGourty, James Eugene.
D	McGovern, Catherine Elizabeth.
D	McGrath, Bernard Francis.
A	McGrath, John Edward.
D	McGrath, William Fennelly.
A	McGuigan, John Joseph.
E	McGurn, William J.
E	McHugh, John Francis.
D	McInerny, John Michael.
D	McIntee, Michael Joseph.
A	McIntire, David.
E	McIntire, George Francis.
A	McIntosh, Donald M.
D	McIntosh, Edward Francis.
D	McIntosh, Elizabeth Ellard.
A	McIntosh, Frederic Lemont.
D	McIntosh, Herbert.
D	McIntosh, John David.
E	McIntosh, William Henry.
A	McIntosh, William Page.
A	McIntyre, Herbert Bruce.
D	McKechnie, Frederick Joseph.
D	McKeen, Sylvester Forshay.
A	McKenna, Frank A.
A	McKenna, Francis Patrick.
E	McKenna, James Charles.
A	McKenty, Jonathan Thomas Edmund.
A	McKenzie, John Robert.
D	McKibben, William Watson.
B	McKinstry, John Alexander.
D	McKnight, Adam Stephenson.
A	McKoan, John William.
D	McLaren, Alexander Lorne.
A	McLaughlin, James Stephen.
A	McLaughlin, Henry Valentine.
A	McLaughlin, Joseph Ignatius.
D	McLaughlin, Patrick William.
A	McLaughry, Elizabeth.
A	McLean, Charles.
D	McLean, James Clifford.
E	McLean, Norman Thomas.
D	McLean, William Corbett.
D	McLellan, Archibald Colin.
A	McLellan, Edward Augustus.
A	McLennan, Roderick.
D	McLeod, John Scott.
A	McLeod, Percy DeMille.
D	McLeod, William McKenzie.
D	McMann, William Henry.
A	McMichael, Willis Brooks.
A	McMillan, Isaac Murray.
D	McMillan, Kate.
D	McMurray, Francis Michael.
D	McNair, Robert Hamilton.
D	McNally, David Albin.
A	McNally, William Joseph.
D	McNally, William Peter.
D	McNamara, Edmund James.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D McNamara, Eugene Thomas.
D McNamara, John James.
E McNamara, Thomas Francis.
D McNeil, Archibald.
D McNeil, Edmund Johnson.
E McNeish, Alexander.
A McOwen, Timothy Edward.
A McOwen, William Henry.
D McPherson, George Edwin.
D McPherson, Ross.
A McPherson, William Ellsworth.
D McQuaid, Thomas Bernard.
A McQueeney, Francis Joseph.
D McSheehy, Theobald Coleman.
D McSweeney, Daniel Justin.
D McWilliams, John Leslie.
D Mead, Frederick Ammi.
A Mead, George Nathaniel Plumer.
A Mead, Julian Augustus.
D Mead, Louis Guy.
A Mead, William Frederick.
A Meader, Charles Eugene.
A Meagher, Michael John.
A Means, Andrew Fuller.
E Means, Philip Corydon.
D Meara, Frank Sherman.
D Medina, Frederick Emanuel.
D Medlar, Faith Curtis.
D Meehan, Patrick Joseph.
D Meek, Edith Ruth Eliza.
A Meeker, George.
A Mehegan, Daniel Joseph.
A Mehrenlender, Albert Nochim.
D Meigh, Josiah.
A Meigs, Joe Vincent, Jr.
C Meigs, Jonathan Harding.
A Meigs, Return Jonathan.
D Meikle, Robert Howard.
E Meisenbach, Roland Otto.
A Mellen, William Michael Edward.
D Mello, Antonio Amor de.
E Mellus, Edward.
A Mellus, Edward Lindon.
A Menard, Anthyme Sylvestre.
D Mendelsohn, Louis.
D Meramble, Clarence Eugene.
A Mercer, William James.
A Mercer, William Marcelline.
D Mercier, Joseph Euclide.
A Merriam, Frances Adelaide.
E Merriam, Franklin Henry.
A Merrick, Robert Michael.
D Merrick, Sara Newcomb.
A Merrill, Arthur Ellsworth.
D Merrill, Quincy Heald.
D Merrill, Theodore Clarkson.
D Merrill, Tristram Hurd.
A Merrill, William Howe.
A Merritt, Louis Arthur.
A Merritt, Silas Virgil.
D Merritt, Victor Sulviro.
A Merry, William Henry.
A Messer, Charles Carson.
D Messinger, Harry Carleton.
A Metcalf, Ben Hicks.
B Metcalfe, Stephen Michael Ryves.
D Metzger, Butler.
D Meyer, Adolf.
D Meyer, Edward James.
D Meylan, George Louis Julien.
D Middleton, Willis Johnson.
A Mignault, Armand.
A Mignault, Arthur.
D Mignault, Louis Joseph Adolphe.
A Mignault, Rodrique.
A Mignault, Victor.
A Milan, Michael Bernard.
A Miles, Charles Edwin.
A Miles, George Albert.
A Millard, Henry James.
A Miller, Albert Eber.
A Miller, Albert Monroe.
A Miller, Charles Hermann.
D Miller, Edward Alexander.
A Miller, Edward Roscoe.
D Miller, Elmer Manton.
A Miller, Ernest Parker.
B Miller, Frances Jane.
D Miller, Harry Clay.
D Miller, Henry William.
D Miller, James, Jr.
D Miller, Jared Homer.
E Miller, Lester Colwell.
A Miller, Lizbeth Dora.
A Miller, Norman Rogers.
D Miller, Samuel Osgood.
A Miller, Vesta Delphine.
A Miller, Webster.
A Millerick, Daniel Edward.
A Millet, Wilfred Antonio.
A Millett, Charles Sumner.
D Milliken, Charles Warren.
D Milliken, Roscoe Green.
A Milliken, William Hardy.
E Mills, Augustus Webster.
A Mills, George Westgate.
A Milot, Alphonse Francois.
D Milot, Wilfred Francois.
D Minard, Ralph Waldo.
D Miner, Jennie Theodate.
A Miner, Worthington Warner.
A Minot, James Jackson.
A Minot, John Francis.
D Minshall, Arthur Gladstone.
A Mintz, Fishel Tonchel Zelmarowich.
A Mitchell, Arthur.
A Mitchell, Charles Henry.
D Mitchell, Ethel Susanna.
D Mitchell, Harry Walter.
D Mitchell, John Joseph.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

B Mitchell, John Singleton.
D Mitchell, William.
D Mitchell, William Hiram.
A Mitchie, James Carey.
A Mixter, Orlando.
A Mixter, Samuel Jason.
A Moffatt, George Tufton.
A Moffitt, Carl Walmer.
A Moffitt, Herbert Charles.
D Moir, Archibald Campbell Milton.
A Molin, Isaac.
D Moline, Charles.
A Moll, Louis Arthur.
A Molleur, Louis Francois.
D Molter, Herman Louis.
D Moomjian, Sarkis K.
E Monahan, John Ambrose.
A Mongan, Charles Edward.
A Monks, George Howard.
D Monroe, John Eugene.
B Monroe, Thomas Wilson.
D Montague, Charles Elbert.
D Montgomery, Mary Louise.
A Monteiro, Manuel Garcia.
A Mooers, Charles Albert.
A Mooers, Emma Wilson.
A Mooney, Philip.
D Moore, Elmer Ellsworth.
D Moore, Frederick Fiske.
E Moore, George Andrew.
D Moore, George Colton.
D Moore, Harry.
A Moore, James Herbert.
D Moore, James Spencer.
D Moore, John Henry.
A Moore, John Patrick.
E Moore, Philip Patrick.
D Mooring, Scott Webber.
A Moran, Horace Sheridan.
D Moran, James Joseph.
A Moran, John Brennan.
A Moran, Martin William.
D Moran, William.
D Morey, Mary.
A Morgan, John.
D Morgan, John Albert.
A Morgan, Lewis Edwin.
D Morgan, William Edward.
D Morgner, Richard August.
D Moriarty, James.
D Moriarty, James Lignori.
D Morin, Harry Franklin.
D Morin, Jacob Mauritz.
A Moroney, William Joseph.
A Morong, Arthur Bennett.
A Morrill, Charles Plummer.
A Morrill, Ferdinand Gordon.
A Morrill, Frank Armington.
B Morrill, Frederick.
B Morrill, George Albert, Jr.
A Morrill, Henry Brown.
A Morris, Frances Morris.
D Morris, Frederick Otis.
A Morris, George Patrick.
A Morris, James Stewart.
A Morris, John Galvin.
A Morris, Michael Augustine.
D Morris, Richard Holt.
D Morris, Robert.
E Morrison, Archibald Benjamin.
D Morrison, Charles Carr.
A Morrison, James.
A Morrison, Robert Edgar.
D Morrison, Robert Francis.
A Morrison, William Alexander.
A Morrow, Charles Harvey.
D Morrow, William Robert.
A Morse, Abby Swan.
A Morse, Almon Gardner.
A Morse, Charles Ellsworth.
A Morse, Charles Francis.
D Morse, Charles Frederick.
A Morse, Charles Wheeler.
A Morse, Edward Gilead.
A Morse, Frank Adelbert.
A Morse, Frank Leander.
A Morse, Fred Harris.
D Morse, Frederick Otis.
A Morse, George.
B Morse, George Franklin.
C Morse, Henry Lee.
A Morse, John Aline William.
E Morse, John Hinckley.
A Morse, John Lovett.
A Morse, Martin Van Buren.
D Morse, Nathaniel Niles.
A Morse, Nathan Ranson.
A Morse, Robie Sidney.
D Morse, Seth Bradford.
D Morse, Vernon Harcourt Chipman.
D Morton, Arthur Oscar.
A Morton, Helen.
D Mosher, Frank Orson.
D Mosher, Harris Peyton.
A Mosher, Marshall James.
A Mosher, Mary Edna.
D Mossman, Alvaro E.
A Mott, Albert.
A Mott, Walter.
A Moulton, Albert Roscoe.
D Moulton, Arthur Bertram.
A Moulton, Charles Fred.
D Moulton, Star Abner.
A Mowe, Frank Henry.
D Mowry, Classen.
D Moxom, Philip Wilfred Travis.
A Mudge, Kate Gertrude.
D Mullen, John Henry.
D Mullen, Peter James.
D Müller, Carl Andreas.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Müller, Carl Frederick.
A Mulligan, James.
D Mullin, Estella Loretta.
D Mulliner, Mary Rees.
A Mullins, Eugene Norton.
A Mumford, James Gregory.
D Munger, William Richard.
A Munhall, Katharine Stanislaus.
D Munro, Catherine Nisbet.
D Munro, Cranswick Burton.
D Munro, Henry Warren.
C Munro, John Cummings.
D Munroe, Harrington Bennett.
C Munsell, George Nelson.
A Munson, Virgil Hitchcock.
A Murdock, Edward Arthur.
D Murdock, Frederick William.
D Murphy, Arthur Sterling.
D Murphy, Charles Augustus.
A Murphy, Daniel David.
D Murphy, Edward Frederick.
D Murphy, Edward Martin.
E Murphy, Edward Vincent.
A Murphy, Emily Frances.
A Murphy, Francis Charles.
D Murphy, Frank Augustine.
D Murphy, Fred Towsley.
D Murphy, Jeremiah Edward.
A Murphy, John Henry.
A Murphy, John McKonkey.
A Murphy, Joseph Briggs.
C Murphy, Joseph Patrick.
E Murphy, Patrick William.
E Murphy, Stephen Nicholas.
D Murphy, Thomas William.
A Murphy, Timothy Joseph.
D Murray, Charles Albert.
A Murray, Edward Francis.
D Musgrave, Percy.
D Musso, George Henry.
A Muttart, George Morley.
E Myers, Edward Everett.
D Myers, Laura Theodosia.
E Myers, Samuel William.
D Myers, Solomon.
D Myles, Leo Thomas.
D Myrick, Hannah Glidden.
D Nagle, Evelyn Wyman.
D Nalchajian, Dikran Davis.
D Narey, William Joseph.
C Nash, George William.
A Nash, Horace Milton.
A Nason, Arthur Clark.
A Nason, Laurentius Melancthon.
A Nason, Osmon Cleander Baker.
D Naughton, John Philip.
D Nay, Winfield Scott.
A Neal, Charles Arthur.
D Neale, Lillian Belle.
A Neefus, Robert Henry.
D Neilson, John Land.
C Neilson, William.
E Nelligan, John Patrick.
D Nelson, David.
D Nelson, John William.
A Nelson, Lois Leverett.
E Nelson, Louis.
D Nelson, William Alexander.
D Nesbitt, Thomas.
E Neuville, Josephine Mitivier de la.
A Newcomb, Elizabeth.
B Newcomb, George Lewis.
D Newcomb, Marietta Eaton.
B Newell, Charles Martin.
A Newell, Frank Samuel.
D Newell, Franklin Spilman.
D Newell, Henry Edward.
A Newell, Otis Kimball.
D Newhall, Alden Russell.
D Newhall, Avery Lester.
A Newhall, Edward.
A Newhall, Herbert William.
A Newhall, Lawrence Thompson.
D Newman, Elizabeth Benham.
E Newman, Leon.
E Newsome, Edgar Thomas.
D Newton, Aaron Lewis.
D Newton, Carrie E.
A Newton, Edward Cazneau.
D Newton, Edward Roswell.
A Newton, Eleanor Frost.
A Newton, Frank Loomis Sabin.
D Newton, Leroy Allan.
A Newton, Sarah Fenno.
D Newton, William Curtis.
A Nichols, Arthur Howard.
B Nichols, Charles Edward.
A Nichols, Charles Fessenden.
A Nichols, Charles Lemuel.
A Nichols, Edward Hall.
D Nichols, George Hayward.
B Nichols, Helen Lucinda Clift.
A Nichols, John Holyoke.
A Nichols, John Taylor Gilman.
E Nicholson, Samuel Alexander.
A Nickerson, Asa Harden.
A Nickerson, Franklin.
A Nickerson, George Wheaton.
E Nickerson, John Peter.
A Nickerson, William Jabez.
D Nicol, Philippe Henri.
D Nicola, Charles Chesterfield.
D Nicola, Mary Byington.
D Nield, William Andrew.
D Nielson, Edwin Björne.
E Nightingale, James.
A Niles, Edward Harry.
D Nilsson, Peter.
A Nims, Edward Beecher.
A Niquette, Louis Bartholomew.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Niver, Emmett.
A	Nixon, Alfred John.
A	Nobile, Angelo.
D	Nobile, Gaspare.
A	Noble, Alfred Ira.
D	Noble, Anngenette Fowler.
B	Noka, Benjamin Gardner.
D	Nolan, Frank Wesley.
E	Nolan, William Francis.
D	Nolen, Walter Freeman.
E	Noon, John Joseph.
D	Noonan, Mary Ellen.
A	Noonan, Michael Charles.
A	Norcross, Ernest Freeman.
A	Nordstrom, Cynthia Maria.
D	Normand, Jean Napoléon.
D	Normandin, Alphonse.
A	Normandin, Louis Zephirin.
A	Norris, Albert Lane.
D	Norris, Arthur Perley.
A	Norris, Sarah Frances.
D	Northrop, Clarence Clark.
D	Norton, Chauncey Williams.
A	Norton, Eben Carver.
A	Norton, Eliza Bogart Lawrence.
D	Norton, George Edward.
D	Norton, George Paul.
D	Norton, Herbert Rozelle.
A	Norton, James Safford.
A	Norwood, Ephraim Wood.
A	Nottage, Herbert Percy.
D	Nowland, George Dunn.
A	Noyes, Ernest Henry.
D	Noyes, John Russell.
D	Noyes, Margaret Louise.
A	Noyes, Nathaniel Kingsbury.
A	Noyes, Rufus King.
D	Noyes, Wilbur Fiske.
A	Noyes, William.
E	Nute, Albert James.
D	Nute, Marion.
D	Nutt, Walter Elwyn.
A	Nutter, William Dennett.
D	Nutting, Frederick Harrison.
A	Nutting, William Walace.
A	Nutting, Will Wallace.
D	Nye, Harry Royal.
E	Oak, Charles Arthur.
D	Oakes, Fitz Albert.
D	Oakman, Carl Shepard.
E	Ober, Ralph Beverley.
D	Ober, Marion Helena.
E	O'Brien, Charles Thomas.
E	O'Brien, Daniel Paul.
A	O'Brien, Denis Aloysius.
D	O'Brien, John Charles.
A	O'Brien, John Francis.
D	O'Brien, Joseph Jerimia
D	O'Brien, Loretta Joy.
B	O'Brien, Michael John.
A	O'Brien, Owen St. Clare
A	O'Brien, Philip Thomas.
D	O'Brien, Thomas James.
D	O'Brien, Walter John Leo.
A	O'Callaghan, Denis Francis.
A	O'Callaghan, Mary Vincent.
D	O'Connell, Delia Maria.
E	O'Connell, George Bernard.
A	O'Connell, John David.
D	O'Connell, Joseph Cyril.
D	O'Connor, Charles.
D	O'Connor, Denis Francis.
A	O'Connor, James Bernard.
D	O'Connor, John Edward.
D	O'Connor, John Francis.
D	O'Connor, John Henry.
A	O'Connor, John James.
A	O'Connor, Thomas Hugh.
A	O'Connor, Watkins Roberts.
D	O'Day, George Frederick.
D	Odiorne, Walter Burlingame.
A	Odlin, Charles Cushing.
D	O'Doherty, John Dominaca.
D	O'Donnell, Edmund Emmet.
A	O'Donnell, Francis Michael.
E	O'Donnell, George Thomas.
D	O'Donnell, James Coughlin.
A	O'Donnell, Louis Patrick.
B	O'Donnell, William.
D	Ogden, Charles Ludlow.
A	Ogden, Jay Bergen.
D	Ogilvie, James.
D	O'Hearn, Daniel Aloysius.
D	Ohnesorg, Karl.
A	O'Keefe, Michael Wallace.
A	O'Keeffe, Daniel Thomas.
A	Olds, Frank Williams.
A	O'Leary, Helen Bartlett.
A	O'Leary, Joseph Augustus.
A	Olin, Francis Henry.
B	Olive, Eben.
A	Oliver, Charles Augustus.
A	Oliver, James.
D	Olloqui, Marie Jeanette de.
A	Olmstead, Charles Edward.
A	Olmstead, William Adams.
D	O'Malley, Edward Francis.
A	O'Meara, Michael John.
D	O'Neil, John Walsh.
E	O'Neil, Richard Frothingham.
D	O'Neill, Owen.
A	Oppe, Samuel.
D	Ordway, Charles Anthony.
D	Ordway, Clarence Eugene.
A	Ordway, George Albert.
B	O'Regan, John.
D	O'Reilly, William Francis.
A	O'Reilly, William Joseph.
D	Orr, Jane.
D	Orr, Samuel Sanford.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Osborne, Aaron Sylvanus.
D Osborne, Caroline Amelia.
D Osborne, Ernest Sumner.
B Osceonneo, Charles Edwin.
A Osgood, George Cowles.
C Osgood, George Edward.
A Osgood, Gilman.
A Osgood, Hamilton.
A Osgood, James Henry.
D Osgood, Robert Bayley.
E O'Shea, Daniel Joseph.
C O'Shea, Edward Flavin.
D O'Shea, Joseph Francis.
A Osman, Charles Frank.
A O'Sullivan, Daniel Joseph.
D O'Sullivan, John Joseph.
A Otis, Edward Osgood.
D Otis, Susanna.
A Otis, Walter Joseph.
D O'Toole, Michael James.
D O'Toole, Thomas Henry.
A Ott, George John.
A Otterson, William David.
D Outhouse, John Stanley.
D Overlock, Melvin George.
A Oviatt, George Alexander.
B Owen, James Williamson.
D Owen, Mary Angell.
A Owen, Varillas Linus.
A Packard, Edward Albert.
D Packard, Francis Sylvester.
D Packard, Frederic Henry.
D Packard, George Henry.
A Packard, Horace.
D Packard, Loring Bradford.
A Packer, Edmund Hilliard.
D Packer, George William.
D Packer, Henry Ernest.
D Paddock, Brace Whitman.
A Paddock, William Leroy.
E Padelford, Frank Mason.
A Padula, Thomas Francis.
A Page, Albert Kidder.
C Page, Calvin Gates.
B Page, Charles Edward.
A Page, Charles Whitney.
A Page, Charlotte Evans.
A Page, Edward.
A Page, Frank Wilfred.
D Page, Frederick Carroll.
D Page, George Thornton.
A Page, Harstein Wendell.
D Page, Joseph Gregory Elias.
B Page, Margaret Beulah.
D Page, Peirson Sterling.
E Pagliuca, Frank Anthony.
A Paige, Nomus.
D Paine, Alonzo Kingman.
A Paine, Amasa Elliot.
F Paine, Ara Marshall.
A Paine, Nathaniel Emmons.
D Painter, Charles Fairbank.
A Palardy, Joseph Hector.
D Palecek, Albina Marie.
D Palfrey, Francis Wilson.
A Palmer, Ezra.
A Palmer, George Monroe.
A Palmer, Lewis Merritt.
A Palmer, Sarah Ellen.
B Papineau, Louis Joseph.
D Paquin, Elzear.
D Paquin, Ubalde.
A Parcher, George Clarence.
D Pariseau, William.
A Park, Francis Edwin, Jr.
A Park, Isaac Park.
A Park, James Timothy.
A Park, John Gray.
D Park, Osmond Franklin.
D Parker, Albert Munro.
E Parker, Arthur Holmes.
A Parker, Charles Edwin.
D Parker, David Woodbury.
D Parker, Edward Grahame.
D Parker, Edward Oliver.
A Parker, Edwin Monroe.
B Parker, Ernest Kent.
D Parker, Ernest Lawrence.
A Parker, Francis Fullam.
A Parker, Frank Howard.
A Parker, Harriet Eliza.
D Parker, Helen Schlesinger.
D Parker, Henry Caldwell.
C Parker, Henry Ward.
D Parker, Jabez Sparks.
D Parker, John Howard.
A Parker, Moses Greeley.
D Parker, Ralph Walter.
A Parker, Rufus Stanly.
A Parker, Rupert William.
D Parker, Walter Henry.
A Parker, Wallace Asahel.
A Parker, William Thornton.
D Parkhurst, Daniel Burleigh.
A Parkhurst, Luman Boyden.
A Parks, Edward Luther.
A Parks, John Wilson.
D Parks, Margaret.
A Parks, Silas Henry.
A Parmalee, William Josiah.
D Parmenter, Kenneth Raymond.
D Parodi, Teofilo.
D Parr, John.
B Parris, John Bowers.
D Parry, Eleanor.
D Parsons, Payn Bigelow.
D Parsons, Clarice Johnston.
D Parsons, Frank Sears.
A Parsons, Harry Snow.
A Parsons, John Eleazer.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Partree, Homer Tomlinson.
A Partridge, Charles Catlin.
A Partridge, Frank Joseph.
A Partridge, Thomas Jefferson.
D Pascoe, James Botterell.
A Pascoe, William Whelan.
A Passoff, Edward Jacob.
D Pastene, Albert Angelo.
D Patch, Ann Sophia Kenney.
A Patch, Frank Wallace.
D Patch, Jennie June.
A Patch, William Thurston.
A Patenaude, Samuel.
B Patrick, Joseph Edward.
A Patrick, Thomas William.
D Pattee, Asa Lee.
A Patten, Anthony Dimock.
D Patten, Stephen Kerr.
D Patterson, Agnes Christy.
A Patterson, Alice Maria.
D Patterson, Alice Zelia.
E Patterson, Belle French.
D Patterson, Charles Frederick.
A Patterson, David Nelson.
C Patterson, William Francis.
D Patton, Lawrence Finney.
D Paul, Luther Gordon.
A Paul, Walter Everard.
D Paul, Willard Augustus.
A Paulhus, Ovide Maxime.
A Paulig, Frederick August.
D Paull, Chester Alpheus.
D Paulsell, Mary.
A Paun, Amos Bosworth.
D Pavlides, Demosthenes.
A Payne, George Harkness.
A Payne, James Henry.
A Payne, James Henry, Jr.
A Payne, John Howard.
D Peabody, Anna Howe.
A Peabody, Charles Augustus.
D Peabody, Sophia Reed.
D Pearce, Arthur Cushing.
D Pearce, Mary Alice.
A Pearce, Richard Mills.
D Pearl, Frederick Warren.
D Pearson, Charles Lusby.
A Pearson, John William.
A Pearson, Mary Morey.
A Pearson, Maurice Wellesley.
E Pearson, William.
D Pease, Charles Valentine.
D Pease, Charles Wood.
A Pease, Edward Allen.
D Pease, Ella Gertrude.
A Pease, Herbert Orrin.
A Pease, James Milton.
D Pease, Lewis Waite.
A Peasley, Emma Janet.
A Peck, Albert Fred.
D Peck, Eugene Chase.
D Peck, Luke Baker.
D Peck, Roy Hamilton.
D Peck, Willena Abby.
A Peckham, Anson Churchill.
A Peckham, Katherine Fenner.
D Peckham, William David.
C Pedrick, Stephen Augustus.
D Peebles, Thomas Chalmers.
D Peggs, Harry MacDonald.
A Peirce, Amos Hagar.
A Peirce, Charles John.
A Peirce, Edward.
A Peirce, Elihu Proctor.
E Peirce, Frederic Joseph.
D Peirce, George Alphonso.
A Peirson, Edward Lawrence.
D Pelletier, Alfred Georges.
D Pelletier, Joseph Edouard.
D Pender, George Edward.
D Pendleton, Ernest Raymond.
D Penny, Herbert Thomas.
D Percy, David Thomas.
A Percy, Frederick Bosworth.
A Percy, George Emery.
D Perkins, Alfred Raymond.
D Perkins, Anne Elizabeth.
A Perkins, Archie Elmer.
A Perkins, Charles Edwin.
D Perkins, Eben Meade.
A Perkins, Henry Phelps, Jr.
E Perkins, Herbert Crawford.
A Perkins, Nathaniel Royal.
A Perkins, Stella Manning.
A Perkins, Thomas Lyman.
D Perkins, Thomas Tounge.
A Perkins, Wesley Bennor.
D Perley, Roscoe Damon.
A Perrins, John.
A Perrins, William Arthur.
A Perry, Arthur Pedro.
D Perry, Arthur Reed.
D Perry, Charles Freeman.
A Perry, Charles Homer.
A Perry, Eben Greeley.
D Perry, Edward Franklin.
A Perry, Edward William.
A Perry, George Lewis.
D Perry, Henry Joseph.
A Perry, Herbert Brainerd.
C Perry, Joseph Frank.
D Perry, Lillian Garabrant.
A Perry, Martha.
D Peters, William Chute.
D Petersen, Alfred Charles Nicholas.
A Petersen, Henrik Georg.
A Peterson, Charles Augustus Burton.
D Peterson, John Adna.
A Petit, Alphonse Hubert.
D Petluck, Joseph.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Pett, Alfred William.
D	Pettee, John Harris.
D	Pettigrew, Richard Richardson.
A	Pfaff, Franz Ludwig Friedrich Ernst.
D	Pfarre, Edward Robert.
B	Pfefferkorn, Charles Hermann.
A	Pfefferkorn, Ferdinand Carl Ludwig.
B	Pfeiffer, Jens Paulus Immanuel.
B	Phelps, James Richardson.
A	Phelps, John Samuel.
E	Phelps, Joseph Royal.
A	Phelps, Olney Windsor.
B	Phillimore, Frederick George.
D	Phillips, Charles Henry.
A	Phillips, Charles Hiram.
D	Phillips, Charles Winfield.
A	Phillips, Eugenie Marion.
D	Phillips, Frank Elmer.
B	Phillips, Freeman Allen.
D	Phillips, John Charles.
D	Phillips, William Converse.
D	Phillips, William Eugarde.
D	Phillips, Wilson Frank.
A	Phippen, Hardy.
D	Phippen, Walter Gray.
A	Phipps, Walter Andros.
D	Pickard, Isaiah Lovell.
A	Pierce, Andrew Martin.
C	Pierce, Appleton Howe.
E	Pierce, Charles Willard.
A	Pierce, Frank Benneville.
D	Pierce, George Burgess.
B	Pierce, George Jacob.
A	Pierce, Helen Frances.
A	Pierce, Matthew Vassar.
A	Pierce, Willard Henry.
D	Pierson, Frederick Harrison.
A	Pierson, Henry Walter.
D	Pierson, John Corbin.
A	Pigeon, James Cogswell Dumaresque.
D	Pike, Forrest Fay.
A	Pike, Forrest Wiley.
A	Pike, Lucy Johnson.
D	Pike, Winfred Carle.
D	Pilling, Simeon Orison.
E	Pillsbury, Boyden Harlin.
D	Pillsbury, Ernest Dean.
E	Pillsbury, Frederick Ainsworth.
A	Pillsbury, George Harlin.
D	Pillsbury, Warren Wilbur.
D	Pinault, Joseph Josué.
B	Pinkham, Arthur Clarance.
A	Pinkham, George Edwin.
A	Pinkham, Joseph Gurney.
A	Piper, Frank.
D	Piper, Fred Smith.
A	Pitcher, Herbert Frank.
A	Pitcher, Samuel.
A	Pitkin, Leonard Fox.
A	Pitman, Benjamin Fosdick.
A	Pitt, Thomas Smith.
D	Pitta, João Carlos da Silva.
A	Pixley, Elbridge Simpson.
D	Place, Ralph Waldo.
E	Plainfield, Mark Henry.
A	Platt, Belle Joanna.
E	Pleau, Louise Beatrice.
A	Plimpton, Lewis Henry.
A	Plummer, Edward Marwick.
D	Plummer, Francis Joseph.
C	Plummer, Frank Wentworth.
D	Plummer, Frederic Howard.
C	Plummer, Henry Lincoln.
A	Plummer, Julia Morton.
D	Plummer, Paul.
E	Plunkett, Harold Brabazon.
A	Plunkett, John Lawrence.
E	Pofcher, Elias Harry.
D	Poirier, Alfred.
A	Poirier, Emile.
D	Poirier, Horace.
E	Poitras, Joseph Francois Xavier.
A	Pollock, Lewis Lawrence.
A	Pomerat, Charles Marius.
D	Pomeroy, Harris Starr.
A	Pomeroy, Hiram Sterling.
A	Pomeroy, Stephen Franklin.
A	Pomeroy, William Henry.
D	Pond, Bernard Wesley.
D	Pond, Eleanor Dorcas.
A	Pool, Charles Bret.
E	Poole, Alva Emory.
E	Poole, Florence Faulkner.
A	Poole, George Fred.
D	Poor, George Ernest.
D	Pope, Ernest Folger.
A	Pope, Frank Fletcher.
A	Pope, Irvine Clarendon.
A	Porter, Charles Allen.
A	Porter, Charles Burnham.
C	Porter, Charles Ilsley.
D	Porter, Elizabeth Dwight.
A	Porter, Francena Elizabeth.
A	Porter, Francis Edward.
D	Porter, Fred Knight.
D	Porter, Herbert Kent.
D	Porter, Margaret Cochran Dewar.
A	Porter, Omer Pillsbury.
D	Porter, Robert Brastow.
D	Porter, William James.
A	Post, Abner.
E	Pote, Leonard Holden.
A	Pothier, Joseph Charles.
D	Potter, Alexander Carleton.
D	Potter, Frances Wason.
A	Potter, La Forrest.
D	Potter, Lester Forest.
D	Potter, Philip Sheridan.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Potter, William Gage.
A Potts, Joseph Henry.
A Poulin, Damase Mark.
D Pound, John C.
D Powell, Jonathan Rider, Jr.
D Powell, Lefferts Morrell.
A Powers, Abner Howard.
A Powers, Edward Joseph.
D Powers, Herbert Hale.
D Powers, William Joseph.
A Pratt, Calvin.
A Pratt, Charles Albert.
A Pratt, Charles Augustus.
B Pratt, Edwin Alton.
D Pratt, John Edward.
A Pratt, John Frank.
A Pratt, John Washburn.
D Pratt, Joseph Hersey.
B Pratt, Samuel Barker.
B Pratt, Thomas Choate.
A Preble, Wallace.
D Préfontaine, Louis Aurèle.
A Prentiss, Harold Townsend.
A Prentiss, Henry Conant.
D Prentiss, Ralph Newbury.
A Presbrey, Silas Dean.
A Prescott, Charles Dudley.
D Prescott, Henry Dudley.
A Prescott, William Herbert.
D Preston, James Louis.
D Prevaux, John Jacob.
E Prevett, Joseph.
D Price, Oscar Jay.
D Price, Walter Herbert.
E Priest, Herbert Bancroft.
A Primeau, Narcisse Arthur.
D Prince, Calvin Oliver.
A Prince, Morton Henry.
A Prindle, Charles Henry.
A Prior, Charles Edwin.
D Prior, James Edward.
D Prior, James Howland.
D Prisco, Nicola.
E Pritchard, William Percival.
A Procter, Percy Clement.
A Procter, Thomas Walter.
A Proctor, Francis Ingersoll.
B Proctor, Hannah Maria.
D Proctor, John Donald.
E Proctor, Joseph Whipple.
A Proulx, Jean Thomas Phillias.
A Prouty, Albert Henry.
C Provan, Robert.
D Provandie, Paul Hector.
D Pulsifer, Thomas Benton.
A Purcell, Thomas Aquinas.
D Purdy, Frank Le Roy.
D Purinton, Herbert Harmon.
D Purvis, Alice Hatheway.
D Purvis, Charles Burleigh.
A Putnam, Charles Pickering.
D Putnam, Charles Russell Lowell.
C Putnam, Charles Willis.
D Putnam, Frank Wendell.
A Putnam, James Jackson.
A Putnam, Joseph Morrill.
D Putnam, Marion Zachariah.
A Putnam, Mary Parks.
D Putnam, Ralph.
A Putnam, Thomas Joy.
A Putnam, Willard Abram.
A Qua, Lester Robert.
A Quackenboss, Alexander.
D Quessy, Alfred Henry.
D Quimby, Charles Morris.
A Quimby, Sumner Ferdinand.
A Quinby, Hosea Mason.
E Quinby, William Carter.
D Quinlan, Henry Francis.
D Quinn, John Joseph.
A Quint, Norman Perkins.
D Råbergh, Herman.
A Rabethge, Charles Armand.
A Rabinovich, Helen.
D Rabinowitz, Solomon.
D Racine, Ernest Eusèbe.
D Radcliff, Sue.
A Raddin, Frederick Stocker.
D Ramos, Frank Inkerman.
E Ramsey, Frank William.
A Rand, John Prentice.
A Rand, John William.
A Rand, Nehemiah Wheeler.
A Rand, Richard Baxter.
D Randall, Arthur Theodore.
B Randall, Charles H.
A Randall, Charles Lawrence.
D Randall, Clifford Walcott.
A Randall, Francis Drew.
D Randall, George Merrill.
B Randell, Otis Gray.
A Rankin, Thomas David.
D Ranks, Walter Hildreth.
A Ranney, Archibald.
D Ransom, Eliza Taylor.
C Ransom, Nathaniel Morton.
B Rappoport, Abraham.
A Rarsch, Harriet Eleanor Lothrop.
D Ravich, Simon.
A Rawson, Charles.
A Rawson, George Wallace.
C Ray, John Edward.
D Raymond, Charles Nevier.
D Raymond, Loring Hay.
A Raymond, Richard Michael.
D Raynes, Myrton Berry.
E Read, Fayette Edmund.
D Read, Willard Fulton.
D Reagh, Arthur Lincoln.
D Rearden, Thomas Francis.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Reardon, Daniel Bartholomew.
D	Reardon, Timothy Joseph.
D	Record, Wellington.
D	Reddy, Joseph Warren.
A	Redfearn, Joseph.
A	Redmond, James William.
D	Redmond, Thomas Henry.
A	Reed, Albert Church.
A	Reed, Andrew Fairfield.
C	Reed, Asa Pingree.
D	Reed, Caroline Thyng.
A	Reed, Clara Deborah Whitman.
A	Reed, Robert Gates.
A	Reed, Thomas Greenhalgh.
D	Reed, Victor Augustus.
D	Reed, William Edward.
A	Reed, William Gilman.
B	Reeder, Albert.
D	Rees, Rees Bynon.
A	Reeves, Harriet Elmira.
D	Reeves, Marcellus.
D	Register, Walter Roland.
D	Reid, Eustace Palmer.
E	Reid, Francis Walsh.
D	Reid, Isidore Eugene Rosenstein.
A	Reid, Robert Alexander.
D	Reilly, Charles Francis.
D	Reilly, James Aloysius.
D	Reilly, Thomas Ignatius.
D	Reis, Frederick.
D	Remillard, Joseph Laury.
A	Remington, John Alfred.
E	Rencurrel, Manuel Emile.
A	Reynolds, Edward.
A	Reynolds, Henry Vose.
B	Reynolds, Hiram Creamer.
C	Reynolds, John Phillips.
A	Rhoads, George.
D	Rhodes, Frank Edson.
A	Rice, Albert James.
A	Rice, Albert Raymond.
E	Rice, Alexander Hamilton.
D	Rice, Alger William.
B	Rice, Austin Bradford.
D	Rice, Carrie Elizabeth.
A	Rice, Charles Henry.
A	Rice, Frederick Winslow.
D	Rice, Florence Frances.
A	Rice, George.
A	Rice, George Brackett.
A	Rice, George Le Roy.
A	Rice, Harry Edwin.
E	Rice, Robert Astley.
D	Rice, Thomas.
D	Rice, Walter Henry.
D	Rich, Charles Edwin.
E	Rich, Edwin Willis.
A	Rich, Frank Urbanus.
D	Rich, Herbert Lowell.
D	Richard, Alfred Edouard.
A	Richard, Marcel.
A	Richards, Caroline Maria.
A	Richards, George Edwards.
A	Richards, George Lyman.
D	Richards, Karle Taylor.
A	Richards, William.
A	Richardson, Anna Gove.
A	Richardson, Benjamin Franklin.
D	Richardson, Charles Harper.
D	Richardson, Dana Putnam.
A	Richardson, Edward Blake.
D	Richardson, Elizabeth May.
A	Richardson, Emily Metcalf.
E	Richardson, Francis Allen.
A	Richardson, Frank Chase.
D	Richardson, Joseph Warren.
A	Richardson, Mark Wyman.
A	Richardson, Maurice Howe.
A	Richardson, William Lambert.
A	Richardson, William Shedd.
A	Richmond, Ernest Dalton.
E	Richmond, Fred Marcy.
D	Richmond, Ivus Irvin.
D	Richmond, Lauriston Amaziah.
D	Richmond, Mary Lovejoy.
D	Richmond, Simon.
A	Ricketson, Arthur.
D	Rideout, Herman Leslie.
D	Riemer, Hugo Bruno Charles.
D	Riley, Elizabeth Angela.
A	Riley, John Henry.
E	Riley, William Norton.
A	Ring, Allen Mott.
D	Ring, Arthur Hallam.
D	Ring, Barbara Taylor.
B	Riopelle, Alexander Joseph.
D	Riordan, Walter Daniel.
A	Ripley, Frederick Jerome.
D	Ripley, Horace Greeley.
A	Ripley, William King.
E	Ripley, William Littlefield.
D	Ritter, Henry.
C	Rix, Frank Reader.
D	Roach, George Ernest.
D	Robb, William Matthews.
D	Robbins, Chandler.
A	Robbins, Elliott Daniel.
D	Robbins, Elmer Ellsworth.
D	Robbins, Eugene Stanley.
A	Robbins, Fred Gibson.
D	Robbins, Fred McAuslan.
D	Robbins, Frederick Carver.
A	Robbins, James Henry.
D	Robbins, Michael Uriah.
D	Robbins, William Bradford.
E	Robert, Albert Napoleon.
E	Robert, George Clovis.
A	Roberts, Dolphin Pernanders.
D	Roberts, Frank Eugene.
D	Roberts, Frederick Albert.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Roberts, Frederick Alpha.
A	Roberts, George Kerr.
A	Roberts, Henry Ambrose.
A	Roberts, Isaac Lincoln.
A	Roberts, Linneus Alton.
E	Roberts, Lucius Warren.
D	Roberts, Oscar Brown.
A	Roberts, Oscar Samuel.
A	Roberts, Oscar Waldo.
A	Roberts, Osmon Osmore.
D	Roberts, Stephen Martindale.
D	Roberts, William Frederick.
D	Robertson, Frederick McNaughton.
A	Robertson, James Douglas.
D	Robertson, Wilbur Burdett.
C	Robey, William Henry, Jr.
A	Robie, Walter Franklin.
A	Robinson, Albert Brown.
A	Robinson, Alexander Lincoln.
D	Robinson, Ernest Franklin.
A	Robinson, Ernest Frederick.
A	Robinson, Florence Nightingale.
D	Robinson, Francis Arnold.
D	Robinson, Fred Hilliard.
D	Robinson, Fred Israel.
D	Robinson, Harry Pringle.
D	Robinson, Herbert Winslow.
D	Robinson, James Arthur.
D	Robinson, Joseph.
D	Robinson, Joseph Alexander.
A	Robinson, Joseph Henry.
A	Robinson, Lucy Morton.
D	Robinson, Mary Emma Bliss.
B	Robinson, Millard Lyman.
D	Robinson, Philip Eaton.
D	Robinson, Samuel.
A	Robinson, Thomas Johns.
A	Robinson, Wilhelmus Bogart.
A	Robinson, William Henry.
D	Robinson, William Perry.
E	Robison, Alice Anna.
D	Robson, Charles Edward.
D	Roche, Thomas Francis.
D	Rochette, Edward Charles.
A	Rochette, Louis Victor.
D	Rockafellow, John Chester.
E	Rockwell, Alfred Elijah Perkins.
D	Rockwell, Herbert George.
A	Rockwell, John Arnold.
D	Rockwell, John Arnold, Jr.
D	Rockwell, Marion Balfour Marshall.
D	Rodrick, Albert Fowler.
B	Roff, Moses.
A	Rogers, Albert Edward.
D	Rogers, Charles Cummings.
D	Rogers, Charles Eugene.
A	Rogers, Charles Rufus.
E	Rogers, Daniel Eastman.
A	Rogers, Frank Alvin.
D	Rogers, Gorham Davis.
D	Rogers, John Conway, Jr.
D	Rogers, Mark Homer.
A	Rogers, Orville Forrest.
B	Rogers, Triton Raphel.
A	Rohrer, Sofier Rudolf.
A	Rolfe, William Alfred.
A	Rollins, Charlotte Abbie.
E	Rollins, Edwin Theodore.
A	Rollins, William Herbert.
D	Romei, Troiano.
D	Rood, Luther Colby.
B	Root, Alice Lucinda.
B	Root, John Reynolds.
A	Root, Richmond Barbour.
D	Rosa, Henry Antonio.
B	Roscoe, Tom.
E	Rose, Alwyn.
A	Rose, Daniel Campbell.
D	Rose, Julius Townsend.
D	Rose, William Henry.
E	Rose, William Milton.
A	Roseman, Milton Joseph.
D	Rosenfeld, Bertha Agnes.
E	Rosenthal, Charles.
D	Ross, Ellsworth Frank.
D	Ross, Frank Augustus.
A	Ross, George Ivison.
D	Ross, Lydia.
D	Ross, Robert Oswald.
D	Ross, Walter Howard.
B	Rosson, Emma.
A	Rotch, Thomas Morgan.
A	Roth, Edward.
D	Rotheram, Marie Cecelia.
D	Rothfuchs, Charles Christian.
D	Rothwell, Charles Robert.
D	Rotondi, Leopoldo Francesco.
A	Roulier, Jacobum Phillippe.
A	Round, Arthur Morey.
D	Rounds, Daniel Willis.
D	Rounds, George Herbert.
A	Rourke, Joseph Edward.
A	Routhier, Michael Omer.
A	Rovinsky, Alexander.
A	Rowe, Alice Eliza.
A	Rowe, George Howard Malcolm.
C	Rowen, Henry Stanislaus.
D	Rowland, Russell Sturgis.
A	Rowley, William.
A	Roy, James McDonald.
D	Roy, Joseph Ferdinand Elzear.
A	Roy, Joseph Hormidas.
D	Roy, Joseph Napoleon.
D	Roy, Joseph Napoleon.
A	Roy, Louis Joseph.
A	Roy, Pramath Nath.
A	Royal, Herbert Benjamin.
A	Ruddick, William Henderson.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Ruggles, Edwin Parkenham.
A	Ruggles, Willard Osman.
D	Rumrill, Samuel Dudley.
D	Rundlett, David Livingston.
A	Runnells, Andrew Jackson.
A	Ruppel, Emil Carl Fraser.
A	Ruppel, Myra Daniel Allen.
C	Russegue, Henry Elmore.
D	Russell, Edward Ervin.
D	Russell, Edward Mark.
A	Russell, Flora Smith.
D	Russell, Frederick James.
A	Russell, Frederick William.
A	Russell, John Henry.
B	Russell, John Perkins.
C	Russell, Julia Ann Bray.
C	Russell, Simon James.
A	Russell, Trueman Everett.
D	Russell, Walter Aloysius.
D	Russell, Walter Burton.
A	Russell, William Henry.
D	Russell, Willis Adams.
B	Rust, Charles Manning.
D	Rust, Frank Lee Drummond.
D	Ruston, Warren Dunn.
D	Rutter, Clara Hannah Rogers.
D	Ryan, Dennis Matthew.
D	Ryan, George Whitehouse.
A	Ryan, John Lawrence.
A	Ryan, Philip Marcellus.
A	Ryan, William John.
D	Ryder, Charles Edward.
D	Ryder, George Hale.
A	Ryder, Godfrey.
D	Ryder, James William.
A	Sabine, George Krans.
D	Sabine, Jane Downes Kelly.
A	Sackett, Harry Robert.
A	Safford, Moses Victor.
D	Safford, Wilber Pray.
D	Salakian, Esther Kevork.
A	Saltmarsh, Seth.
A	Sampson, Lottie Emma.
B	Sampson, Nellie.
D	Sanborn, Byron.
A	Sanborn, Edwin Aaron.
A	Sanborn, Emma Mary Eastman.
E	Sanborn, Fletcher Greene.
A	Sanborn, Frederick James.
D	Sanborn, Frederick Rodney.
D	Sanborn, George Phippen.
D	Sanborn, John Wesley.
A	Sanborn, Joseph Lander.
A	Sanborn, Kate.
A	Sanborn, Nathan Willard.
A	Sanborn, Perley Lewis.
D	Sanders, Charles Barton.
B	Sanders, Edwin Melvin.
E	Sanders, James Samuel.
A	Sanders, Orren Burnham.
A	Sanderson, James Henry.
D	Sanderson, Mary.
D	Sanford, Alexander Chace.
A	Sanford, Edward.
D	Sanford, Frank Burton.
D	Sanford, Henry Lindsay.
D	Sanford, Margaret McPhee.
D	Sanford, Walter Howard.
A	Sanft, Frank.
D	Sanger, Guy Edward.
D	Santosuosso, Joseph.
D	Sargent, Albert Alonzo.
A	Sargent, Ara Nathaniel.
A	Sargent, Charles Samuel.
C	Sargent, George Amory.
A	Sargent, George Bancroft.
A	Sargent, Lorenzo Dow.
D	Sargent, Oscar Franklyn Libby.
D	Sargent, Walter Leslie.
D	Sauer, Emil.
A	Saunders, Ambroze Courtis.
D	Saunders, Edward Louis.
D	Saunders, Joseph Henry.
F	Saunders, Levi.
D	Saunders, Thomas Henry.
D	Savage, Grace Gertrude.
D	Savage, Ross Eliot.
A	Savard, Alfred Henry.
A	Savignac, Arthur.
C	Saville, Sumner Carruth.
D	Sawabini, Elias.
A	Sawin, Charles Dexter.
A	Sawin, Robert Valentine.
A	Sawtelle, Benjamin Albert.
A	Sawtelle, George Bassett.
A	Sawtelle, Henry Winchester.
D	Sawyer, Alfred Stanford.
A	Sawyer, Alzaman.
A	Sawyer, Benjamin Addison.
D	Sawyer, Carleton.
A	Sawyer, Charles Milton.
D	Sawyer, Edward Allen.
E	Sawyer, Edward Keyes.
A	Sawyer, Elihu LeRoy.
B	Sawyer, Emily Harriet.
A	Sawyer, Frank Wade.
A	Sawyer, Herbert Houston.
B	Sawyer, Katie Sarah.
A	Sawyer, Walter Fairbanks.
A	Sawyer, Wesley.
A	Sawyer, Willis Herbert.
D	Sayles, Joseph Borland.
D	Sayward, William Henry, Jr.
D	Scales, Robert Bass.
D	Scalzilli, Erico Arnaldo.
D	Scanlan, Thomas John.
E	Scannell, David Daniel.
A	Scannell, Michael Edward.
D	Schaefer, August Theodore.
E	Schallenbach, Ernest Bradford.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Schenck, Ellen Eastman.
A Schiller, Louis Edouard.
E Schmidt, Frederick Sextus.
D Schmidt, Richard Diedrich.
A Schneider, Jacob Philip.
D Schofield, Benjamin Franklin.
D Schofield, Otho Lester.
D Schoonmaker, Arthur Twing.
D Schorer, Cornelia Bernhardine Johanna.
D Schroeder, May Catherine.
D Schubmehl, Frank Edward.
D Schultes, Hugo, Jr.
D Schultz, Simon Robert.
D Schwartz, Myer.
D Schwartzman, Samuel.
C Scoboria, Arthur Gilmore.
A Scofield, Walter.
B Scott, Charles Winfield.
A Scott, Cyrus Wallace.
A Scott, Gavin Steel.
E Scott, George Dow.
B Scotti, Federico.
A Scribner, Ernest Varian.
A Scudder, Charles Locke.
A Seaman, William.
A Searle, George James.
D Searles, Frank Rufus.
A Sears, Eloise Augusta.
D Sears, Frederick Manning.
A Sears, George Gray.
D Sears, Harry Edward.
C Sears, Henry Francis.
D Sears, Stephen Hull.
D Sedgewick, Otis White.
D Sedgley, Frank Robert.
A Seelye, Hiram Henry.
A Seelye, Ralph Holland.
E Seelye, Walter Clark.
B Segool, Hyman.
A Segur, Willard Blossom.
A Seip, Charles Lewis.
A Selee, Annie Maud.
A Sellew, Philip Hamilton.
D Sellew, Robert Cowan.
A Selling, Leo Milton.
A Selva, Julius.
D Senesac, Archibald.
D Sennott, John Ralph.
B Senter, George Eldredge.
A Serijanian, Tatios Kasbar.
D Sever, James Warren.
D Severance, Ella Eliza.
A Severance, William Lyman.
A Severance, William Sidney.
A Sewell, John Jasper.
D Sewny, Karékeen Hekimian.
D Sexton, Frank Joseph.
D Sexton, James Henry, Jr.
A Seymour, Christopher.
D Seymour, Frederick Ward.
D Seymour, Horace Darling.
A Seymour, James Dwight.
D Seymour, Malcolm.
A Seymour, Susan Pheland.
A Shackford, Charles Harrison.
D Shanahan, Edward Joseph.
A Shanahan, John.
D Shanahan, Thomas Joseph.
D Shanks, Charles.
D Shannahan, Richard Joseph.
D Shannon, James Herbert.
A Shannon, Nat Vaughn.
A Shapira, Israel Jarius Elihaf.
A Shapleigh, Alfred Lindsay.
D Sharp, Leedom.
A Sharp, Walter Nevin.
D Shatswell, James Arthur.
D Shattuck, Albert Milo.
A Shattuck, Charles Harvey.
D Shattuck, Edwin Chase.
A Shattuck, Frederick Cheever.
A Shattuck, George Brune.
A Shaw, Albert Joel.
A Shaw, Arthur John.
B Shaw, Charles Albert.
D Shaw, Francis.
E Shaw, Frederick King.
D Shaw, Harry.
A Shaw, Henry Lyman.
A Shaw, James Stott.
A Shaw, John Cook.
A Shaw, John Holbrook.
A Shaw, John Joseph.
D Shaw, John Port.
A Shaw, Sarah Jane Hutchinson.
D Shaw, Thomas Bond.
A Shaw, Thomas Pierpont.
D Shaw, Thomas Wighall.
D Shaw, William Hubbard.
D Shay, Charles Edwin.
A Shay, Thomas McGuire.
D Shea, Alfred Drake.
D Shea, John Francis.
D Shea, John Joseph.
D Shea, Michael Henry.
D Shea, Michael Ignatius.
D Shea, Peter Owen.
A Shea, Thomas Bernard.
D Shead, Edward Wadsworth.
E Sheahan, Joseph Maurice.
E Shean, Maurice Edwin.
D Sheedy, John Francis.
E Sheehan, Martin David.
A Sheehan, William Joseph.
D Sheehan, William Joseph.
A Sheehy, William Clinton.
A Sheldon, Chauncey Cooley.
D Shepard, Luther Dimmick, Jr.
B Shepardson, Oscar Jerome.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

C	Shepherd, Hovey Learned.
A	Shepherd, Susan Symonds.
D	Shepley, Luther James.
E	Sherburne, Andrew Arthur.
E	Sherburne, Frederick William.
A	Sheridan, Oliver Michael.
A	Sherman, Charles Francis.
A	Sherman, Frank Morton.
B	Sherman, James Henry.
A	Sherman, James Turner.
A	Sherman, John.
A	Sherman, John Howard.
A	Sherman, Mary Hastings.
A	Sherman, William Sprague.
D	Sherskefsky, Cecilie Lande.
A	Sherwin, Aurelius Calvin.
E	Sherwood, Walter.
D	Sherwood-Dunn, Berkeley.
A	Shirley, Allen Lincoln.
D	Shine, John Patrick.
D	Shisler, William Henry.
D	Shohan, Joseph.
D	Shoninger, Lee Simon.
A	Shores, Harvey Towle.
A	Shreve, Octavius Barrell.
D	Shrum, Mark.
D	Shultis, Frederick Charles.
A	Shurtleff, Eugene.
A	Shurtleff, Frank Atwood.
A	Shurtleff, Fred Cazeaux.
A	Shurtleff, George Frederick.
A	Shurtleff, Henry Austin.
D	Shurtleff, James Frederick.
D	Shurtleff, Percy Andrew.
D	Shurtleff, Walter Davis.
E	Sibley, Hartwell Astor.
A	Sibley, Hartwell Augustus.
D	Sidis, Sarah Mandelbaum.
A	Sidney, Austin Wilbur.
A	Siggins, John Jacob.
D	Silbert, Joseph Jacob.
B	Sill, John Wellesley.
A	Silva, Francis Pierce.
E	Silver, Frank Rudolph.
D	Simmons, Channing Chamberlain.
A	Simmons, Clara Congdon.
D	Simmons, Fred Albert.
D	Simmons, Hannah Coralynn.
D	Simmons, Orren Williams.
A	Simmons, William Edmund.
D	Simon, Harold Francis.
A	Simonds, Marilla Reed.
A	Simpson, Charles Edward.
A	Simpson, Edmund S.
A	Simpson, George Foster.
A	Simpson, James Edwin.
B	Simpson, John Thomas Lionel.
B	Sims, Charles Hawkins.
D	Sims, Frederick Robertson.
A	Sinclair, Alexander Doull.
A	Sinclair, William Albert.
D	Sinclitico, Guiseppe.
D	Sise, Lincoln Fleetford.
A	Siskind, Alexander Louis.
E	Sissa, Silvio.
A	Sisson, Edward Rotch.
D	Skarstrom, William.
D	Skelton, Grace Evelyn.
D	Skinner, Anna Mabel.
A	Skinner, Edward Manning.
A	Skinner, John.
D	Skolfield, Ezra Byington.
D	Slack, Francis Hervey.
D	Slagle, Sarah Elizabeth.
E	Slate, Ames Wilsworth.
A	Slattery, John Richard.
A	Slayter, John Theodore Harding.
A	Slayton, William Taft.
D	Sleeper, Frank Warren.
D	Sleeper, Karle Raymond.
A	Sleeper, Walter Julian.
D	Slettengren, Oscar.
C	Slocomb, George Albert.
D	Slocum, Clarence Jonathan.
D	Slutskin, Maurice Louis.
D	Small, Albert Ernest.
D	Small, Ernest Winfield.
E	Small, Guy Darwin.
A	Small, Herbert Elwyn.
A	Small, John Wesley.
D	Small, Richard Dresser.
A	Small, Whitmell Pugh.
D	Smalley, Fred Lyman.
D	Smallwood, George Washington.
D	Smart, Frank Everard.
E	Smeltzer, James Finlay.
E	Smith, Alfred Charles.
D	Smith, Appleton White.
A	Smith, Arthur Vincent.
A	Smith, Asa Dennis.
A	Smith, Charles John James.
A	Smith, Charles Morton.
A	Smith, Charles Sherman.
D	Smith, Charles Wesley.
D	Smith, Chiron Waterville.
D	Smith, Conrad.
A	Smith, Daniel Patrick.
B	Smith, David Wiley.
D	Smith, Edward Shepard.
D	Smith, Edwin Wallace.
A	Smith, Ella Gertrude.
A	Smith, Ezra Algernon.
E	Smith, Forster Hanson.
D	Smith, Frank Herbert.
D	Smith, Frank Llewellyn.
A	Smith, Frank Simpson.
A	Smith, Franklin Benjamin.
C	Smith, Fred Stevens.
A	Smith, Frederick Glazier.
D	Smith, George Carroll.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Smith, George Herbert.
A	Smith, George La Breche.
D	Smith, Harold Wellington.
D	Smith, Harry Atherton.
A	Smith, Henry Marcellus.
A	Smith, Herbert Llewellyn.
A	Smith, Hermon Joseph.
D	Smith, Hervey Lewis.
A	Smith, Hiram Fred Markley.
A	Smith, Homer Alvan.
D	Smith, Homer Brandel.
D	Smith, Howard Harry.
D	Smith, James Gardner.
D	Smith, James Jay.
D	Smith, John Hall.
A	Smith, Jonathan Jason.
D	Smith, Joseph Arthur.
A	Smith, Joseph Heber.
B	Smith, Julia Ann Crafts.
B	Smith, Levi Jasper.
D	Smith, Lewis Albert.
D	Smith, Marshall Evans.
A	Smith, Mary Almira.
A	Smith, Murdock Campbell.
D	Smith, Ota Mafry.
D	Smith, Peter Matthew.
E	Smith, Ralph Kendrick.
D	Smith, Samuel Breese.
D	Smith, Samuel Finlay.
A	Smith, Sumner Phinney.
A	Smith, Thomas Burke.
A	Smith, Walter Anson.
D	Smith, William Benjamin Tyng.
D	Smith, William Henry.
C	Smith, William Lord.
D	Smith, William Morgan.
A	Smith, Winfield Scott.
A	Smithwick, John.
C	Smithwick, Marsena Parker.
E	Smorgonsky, David Joseph.
A	Smyth, Herbert Edmund.
D	Smyth, Patrick Somers.
D	Smyser, Charles James.
A	Snow, Asa Vernon.
D	Snow, Frank Whipple.
E	Snow, Frederick Stedman.
D	Snow, Henry Curtis Butler.
A	Snyder, Charles Wight.
D	Snyder, Charles William.
B	Solomon, James Madison.
B	Solomon, Sarah Augusta.
B	Solomon, William Burr.
D	Somers, Henry Elijah.
A	Somers, John Edward.
E	Somers, Pierce Edward.
A	Soper, Lyman White.
A	Sopher, Curtis Levi.
D	Soule, Horace John.
B	Soule, John Albion.
A	Soules, Silas George.
D	Sousa, Jayme Ernesto Salaza D'Eçae.
D	Southard, Elmer Ernest.
D	Souther, Robert Fulton.
A	Souther, William Towle.
B	Southgate, George Alonzo.
A	Southgate, Robert William.
A	Southwick, George Rinaldo.
D	Southworth, Thomas Shepard.
D	Soutter, Robert.
D	Spald, Charles Jacob.
A	Spalding, Charles Franklin.
D	Spalding, Fred Maurice.
D	Spalding, Harry Osgood.
A	Spalding, Henry Edwin.
B	Spalding, Jacob Franklin.
E	Spalding, Roger.
A	Spalding, Samuel Hopkins.
A	Sparhawk, Clement Willis.
D	Sparks, Clarence Irving.
D	Sparks, Ernest Elliot.
D	Sparling, John Henry.
D	Spaulding, Charles Lester.
D	Spaulding, David Nathan.
F	Spaulding, Ebenezer Farrington.
A	Spear, Edmund Doe.
C	Spears, George William.
B	Spencer, Emily Jone.
C	Spencer, George Albert.
A	Spencer, George Frederick Allen.
A	Spencer, William Warren Conant.
A	Spooner, George Robert.
E	Spooner, Henry Garrettson.
A	Spooner, John Winthrop.
A	Sprague, George Perry.
A	Sprague, Rufus William.
D	Spratling, Edgar Johnson.
A	Spring, Clarence Walter.
A	Springer, Nathan Ayer.
D	Sproull, John.
E	Sproules, Joseph Aloysius.
A	Squier, Angelo Orin.
E	Stack, Charles Francis.
A	St. Clair, Austin Emery.
A	St. Dennis, Joseph Nelson.
D	St. George, Archibald.
A	St. George, Norman.
A	St. Georges, Wilfred Mark.
A	St. Germain, Joseph Pierre.
A	St. Germain, Valmore.
A	St. Jacques, Joseph Robert.
D	St. Marie, Philippe.
A	Stackpole, George Edmund.
A	Stacy, Charles Franklin.
A	Stafford, Frank Dalmon.
B	Stahl, Alfred Franz.
A	Standish, Myles.
E	Stanley, Francis Guy.
A	Stanley, George Henry.
A	Stanley, Josiah Marsh.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Stanley, Leonard Gove.
D	Stanley, Mark Page.
A	Stanton, Jere Edmund.
D	Stanton, Joseph.
C	Stanton, Thomas Leo.
D	Staples, Clarence Hathorne.
D	Staples, Hall.
D	Staples, John Walter.
A	Stapleton, Richard Henry.
A	Starbird, Edward Perley.
A	Starbird, Isaac Warren.
D	Starbuck, Joseph Clinton.
D	Stark, Maurice Albert.
D	Starkweather, Charles Robert.
B	Starr, Christopher Hamlin.
A	Steadman, John Abraham.
A	Stearns, Charles A.
A	Stearns, Charles Goddard.
A	Stearns, George Washington.
A	Stearns, Isaac Holden.
E	Stearns, John Warren.
E	Stearns, Robert Thomas.
A	Stebbins, George Stanford.
B	Stebbins, Marion Rowena Hayward.
D	Steckel, Charlotte Irene.
A	Stedman, Charles Ellery.
A	Stedman, George.
A	Stedman, Henry Rust.
A	Stedman, James Parker.
A	Stedman, Joseph Cyrus.
D	Steele, Albert Edward.
E	Steele, Harry Leon.
A	Steere, David Roscoe.
B	Steinberg, Joseph.
D	Stenning, William Arthur.
D	Stephens, Edna Harriet.
A	Stephens, Edward Buckminster.
A	Stephenson, Benjamin Swift.
B	Stephenson, Milton Elmer.
A	Stephenson, Nellis Witter.
E	Stepp, Jacob, Jr.
A	Stetson, Clarence Augustus.
D	Stetson, Frank Eliot.
D	Stetson, Frederick Winslow.
D	Stetson, Halbert Greenleaf.
A	Stevens, Andrew Jackson.
B	Stevens, Charles Albert.
A	Stevens, Charles Benjamin.
A	Stevens, Edmund Horace.
A	Stevens, George Beckwith.
D	Stevens, Grace.
A	Stevens, Harry Laurence.
A	Stevens, Henry Burt.
D	Stevens, James Edward.
A	Stevens, James Herbert.
D	Stevens, Michael Mallett.
D	Stevens, Oscar Howard.
D	Stevens, Ralph Emerson.
D	Stevens, Ruey Bartlett.
D	Stevens, Sara Elmina.
A	Stevens, Seriah.
A	Stevens, William Caldwell.
A	Stevens, William Stanford.
D	Stevenson, Arthur William.
D	Stevenson, Willis Mack.
E	Steward, Benjamin Gadsden.
D	Stewart, Abraham Lincoln.
A	Stewart, Anne Clark.
A	Stewart, James.
A	Stewart, James Hope.
D	Stewart, Vernon Champney.
D	Stewartson, Charlotte Dodd.
D	Stick, Henry Louis.
A	Stickney, Alonzo Lawrence.
A	Stickney, Clifford Webster.
A	Stickney, Edwin Pangman.
D	Stickney, Elizabeth Mary.
A	Stickney, George Augustus.
D	Stickney, Henry Constant.
D	Stickney, Whitman Gibson.
A	Stiles, Charles Wallace.
A	Stiles, Fred Merritt.
C	Stiles, Herbert Kendall.
D	Stiles, Ned Carroll.
A	Still, James Thomas.
D	Still, William Henry.
A	Stilson, Willard Charles.
D	Stilwell, Benjamin Watson.
A	Stinson, John Woodbury.
F	Stocker, Alfred Augustus.
D	Stockwell, Edgar Washburn.
D	Stockwell, George Norman.
D	Stockwell, Herbert Emmons.
A	Stoddard, Henry Bradish.
D	Stoddard, Mortimer Joseph.
D	Stodder, Charles William.
A	Stokes, William Royal.
A	Stone, Arthur Kingsbury.
D	Stone, Arthur Lile.
A	Stone, Byron.
A	Stone, Charles Sinclair.
A	Stone, Ella Gertrude.
D	Stone, Ellen Appleton.
A	Stone, Frank Ellsworth.
C	Stone, George Arthur.
A	Stone, James Savage.
A	Stone, Lincoln Ripley.
D	Stone, Moses Cornelius.
D	Stone, Murray Chaffee.
E	Stone, Ralph Edgarton.
D	Stone, Thomas Newcomb.
A	Stone, Waldo Hodges.
D	Stone, Warren Buxton.
B	Stone, Wolf.
D	Stoneman, Edgar Ames.
D	Stoodley, Harry Marr.
A	Storer, John.
A	Storer, Malcolm.
E	Storrs, Henry Randolph.
C	Story, Alvin Francis.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D Story, Helen Louise.
E Stowe, Irving Elmer.
A Stowe, Willard Hanley.
A Stowell, Edmund Channing.
D Stowell, Frank Edgar.
A Stowell, Joab, Jr.
C Stowell, Maud Evelyn
A Stowell, Sarah Russell.
D Stratton, Ralph Ricker.
D Straw, Amos Gale.
D Straw, O'Neil Watson Robinson.
D Strayer, Edgar.
D Street, Charles Edward.
A Street, Jerome Charles
D Street, Lionel Alexander Burnet.
D Streeter, Howard Alvertus.
D Strickland, Samuel Perley.
D Strong, Charles Howard.
E Strong, Frederick Finch.
D Strong, James Henry.
D Strong, Lawrence Watson.
A Strong, Thomas Morris.
D Strout, Arthur Chester.
A Stuart, Frederick William.
A Stuart, James Henry.
D Stubbs, Frank Raymond.
D Stubbs, Richard Henry.
D Sturgis, Benjamin Franklin, Jr.
D Sturgis, Walter Horatio Wakeman.
E Sturnick, Max.
A Sturtevant, Charles.
D Sturtevant, Charles Alton.
D Sturtevant, Louise Martha.
A Stutson, William Peckham.
D Styles, Myron Francis.
A Suffa, George Alson.
D Sughrue, Dennis Francis.
D Sullivan, Charles Brent.
D Sullivan, Cornelius Augustine.
E Sullivan, Daniel Aloysius.
D Sullivan, Daniel Bartholomew.
A Sullivan, Daniel Henry.
D Sullivan, Daniel Thomas.
D Sullivan, Edward Coppinger.
D Sullivan, Eulick Francis.
D Sullivan, Florence Augustine.
D Sullivan, Francis Augustus.
D Sullivan, Frank Aloysius.
A Sullivan, James Francis.
A Sullivan, James Francis.
A Sullivan, James Stephen.
A Sullivan, James Stephen.
B Sullivan, John Francis.
A Sullivan, John Henry.
D Sullivan, John Joseph.
D Sullivan, John Joseph.
A Sullivan, John Thomas.
D Sullivan, John Thomas, Jr.
E Sullivan, Joseph Lawrence.
D Sullivan, Leon Daniel.
D Sullivan, Martin.
A Sullivan, Michael Francis.
E Sullivan, Patrick Eugene.
A Sullivan, William Joseph.
D Sumner, Harry Herbert.
C Sumner, Philip S.
A Suter, William Norwood.
D Sutherland, Jane Hunting.
A Sutherland, John Preston.
D Swain, Howard Townsend.
A Swain, Mary Lizzie.
D Swain, Oliver Alden Tinkham.
A Swan, Charles Louis.
A Swan, Charles Walter.
A Swan, Henry Storer.
D Swan, Horace Cheney.
A Swan, Jesse Johnson.
A Swan, Roscoe Wesley.
A Swan, Will Howard.
A Swan, William Donnison.
A Swan, William Ellery Channing.
A Swasey, Edward.
A Swasey, Oscar Fitzallan.
A Sweeney, Hilary Tucker.
D Sweeny, Margaret Ada.
A Sweet, Charles Frederick.
A Sweet, Clara Maria.
B Sweet, Elisha Wilbur.
D Sweet, Ernest Albert.
D Sweet, Frederick Benoni.
B Sweet, Job.
E Sweet, John Henry, Jr.
B Sweet, Orrin Preston.
D Sweet, Willard Hamilton.
A Sweetser, Frederic Ellsworth.
A Sweetsir, Charles Leslie.
A Swett, George William.
A Swett, Percy Walter.
D Swift, Frederic Norman.
D Swift, Henry Marshall.
A Swift, John Baker.
A Swift, Lawrence Chew.
A Swift, Robert.
A Swift, William Nye.
D Swiney, Merrill Alpheus.
D Swope, Dalva Hamit.
D Swope, Oscar Clinton.
D Sylvester, Charles Porter.
A Sylvester, Stephen Alden.
A Sylvester, William Hillman.
E Sylvia, Charles Anthony.
A Sylvia, Manuel Victorino.
E Symonds, Alice Gertrude.
A Symonds, Benjamin Ropes.
A Synan, William Edward.
D Syrett, Edgar Charles.
D Tabor, Edward Orlando.
D Taft, Albert Atherton.
A Taft, Mary Florence.
D Taft, Maud Emilie.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A Talbot, George Henry.
A Talbot, Winthrop Tisdale.
D Tallant, Alice Weld.
D Tallman, Arthur Doyle.
A Tallman, Augustus Littlefield.
B Tallman, William Cyprian.
D Taminosian, Timotheus.
A Tanner, John Alexander.
E Taplin, Grace Batchelder.
E Taplin, George Colby.
D Tarbell, Harold Appleton.
A Tasker, Frank Edwin.
A Tassé, Joseph Chrysanthe Edward.
A Tatum, Rives.
A Taylor-Cole, Anna Bessie.
A Taylor, Charles Warren.
A Taylor, Edward Wyllys.
D Taylor, Erwin Hartwell.
E Taylor, Francis Albert.
A Taylor, Frederic Weston.
D Taylor, Frederick Leon.
A Taylor, George Lyman.
B Taylor, Henry.
E Taylor, James, Jr.
D Taylor, James Ralph, Jr.
E Taylor, John Danforth.
A Taylor, Jubal George.
D Taylor, Stella Mary.
D Teahan, William John.
A Temple, Franklin Stuart.
A Temple, Hiram.
A Temple, William Franklin.
A Ten Broeck, Stanton Jacob.
A Tenney, Benjamin.
D Tenney, Elmer Seth.
A Tenney, John Arthur.
C Tenney, William Northend.
D Tessier, Charles.
D Tétreau, Thomas.
D Thatcher, Haines C.
B Thayer, Charles Nathaniel.
A Thayer, Charles Paine.
A Thayer, Eugene.
A Thayer, George Dickinson.
D Thayer, Hartley Wales.
A Thayer, Henri Riedelle.
A Thayer, Samuel Chase.
A Thayer, Samuel Ezra.
B Thayer, Washington Irving.
D Thayer, William Hewins.
A Thayer, William Sydney.
A Therrien, Edward Joseph.
E Therrien, John.
A Thissell, Joseph Abbott.
B Thomas, Adelida Annabel.
D Thomas, Carlton Revere.
A Thomas, Caroline Louise.
A Thomas, Charles Holt.
A Thomas, Flavel Shurtleff.
A Thomas, George Francis.
C Thomas, George Henry.
A Thomas, John Jenks.
E Thomas, John Willard.
D Thomas, Raphael Clarke.
D Thomas, William Kilpack Smith.
D Thomasson, Aaron Hood, Jr.
D Thombs, Samuel Brackett.
D Thomes, John Blanchard.
D Thompson, Arthur Percival.
D Thompson, Charles Arthur.
D Thompson, Charles Edward Perry.
D Thompson, Charles Edward.
A Thompson, Charles Marsh.
A Thompson, Charles Oscar.
A Thompson, Eben.
A Thompson, Edward Charles.
D Thompson, Edward Henry.
A Thompson, Frederick Henry.
E Thompson, Frederick Henry, Jr.
A Thompson, George Eben.
D Thompson, George Southwick.
C Thompson, Harry John.
A Thompson, James Gillespie.
D Thompson, John Budd.
B Thompson, John Buxton.
A Thompson, John Henry.
A Thompson, John Joseph.
A Thompson, John McQuaid.
D Thompson, John Stephen.
E Thompson, Joseph Mariner.
B Thompson, Marshall Elery.
D Thompson, Peter Hunter.
D Thompson, Ralph Leroy.
D Thompson, Richard Henry.
A Thompson, Richard Joseph.
D Thompson, Wellington Andrew.
D Thomson, George Felix.
A Thomson, George Francis.
D Thorn, Edwin Cyrus.
A Thorndike, Augustus.
A Thorndike, Paul.
D Thorndike, Townsend William.
D Thorning, William Burton.
A Thornton, James Brown.
B Thornton, William.
D Thorpe, Benjamin Franklin.
A Thorpe, Edward Elephalet.
B Thumin, Samuel.
A Thuot, John Vincent.
A Thurber, Madison Templeton.
E Thurber, Stephen Francis.
B Thurlow, Edgar Theodore.
A Thurlow, John Howard.
A Thurston, Rufus Leander.
A Tibbitts, James Thomas.
A Tierney, Edward Howran.
A Tierney, Martin Henry.
D Tierney, Thomas Francis.
A Tigh, Frederick.
A Tilden, Frank Elmer.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

E	Tilden, Irving Niles.
D	Tileston, Wilder.
A	Tilton, Edward James.
A	Tilton, Frank Herbert.
A	Tilton, Josiah Odin.
A	Tilton, Letitia Marie.
D	Tilton, Nellie Norris.
D	Timmins, Edward Francis.
A	Timmins, Patrick Joseph.
F	Tingley, Benjamin Wilson.
D	Tingley, Louise Paine.
A	Tinker, Martin Buel.
A	Tinkham, Granville Wilson.
A	Tirrell, Vinson Meader.
A	Titcomb, George Eugene.
D	Tobey, Carter McVine.
E	Tobey, Edward Nelson.
A	Tobey, George Loring.
A	Tobey, Walter Henry.
A	Tobin, James Henry.
E	Tobin, John Henry.
E	Todson, Clara Leona.
E	Tolman, Henry, Jr.
A	Tolman, Julia.
A	Tompkins, Albert Henry.
D	Toohey, Thomas Victor.
A	Toomey, John Peter.
A	Toomey, Thomas Patrick.
D	Toothaker, Horace Edward.
D	Topaz, Anna.
D	Torbert, James Rockwell.
D	Torrey, John Paine.
A	Torrey, Noah.
A	Torrey, Samuel William.
D	Totman, Virgil Connor.
A	Tower, Charles Bates.
A	Tower, Frederick Russell.
A	Tower, George Augustus.
D	Towle, Benjamin Newell.
D	Towle, Charles Edward.
D	Towle, Clarence Clarke.
D	Towle, Edwin Dudley.
A	Towle, Fred Scates.
A	Towle, Harvey Parker.
A	Towle, Henry Charles.
B	Towne, Charles Jefferson.
B	Towne, William Alexander.
A	Townsend, Charles Wendell.
D	Townsend, David.
C	Townsend, Willis Merrick.
D	Tozier, Charles Herman.
D	Tracey, John Matthew.
B	Tracy, Christopher Columbus.
A	Tracy, Edward Aloysius.
A	Tracy, Thomas Henry.
A	Trafton, Alonzo Gardiner.
D	Trainor, John Brett.
E	Trask, Harry Wallis.
D	Traver, Alvah Harry.
A	Traver, Edward Clarence.
D	Trayes, William Henry, Jr.
C	Treanor, John Peter.
A	Trecartin, David Munson.
D	Treichler, Albert Julius.
D	Tresilian, Florence Harvey.
D	Treston, Maurice Joseph.
D	Tripp, George Alston.
A	Trow, Cornelius Gilman.
A	Trow, William Marshall.
A	Trowbridge, Edward Henry.
D	Troxell, George Allen.
D	Trudeau, Marc Aurele.
A	Trudeau, Wilfrid.
A	Trudel, Jacques Joseph.
A	True, Herbert Osgood.
D	True, Richard Smith.
A	Trueman, Harmon Silas.
D	Truesdale, Philemon Edwards.
A	Trueworthy, Edwin Weston.
D	Truslow, Walter.
B	Tuck, Lucy Wadsworth.
A	Tucker, Edward Tobey.
A	Tucker, Samuel Chase.
A	Tucker, William Emerson.
A	Tucker, Willis Leroy.
A	Tully, Edward Joseph.
E	Tupper, Arthur Gordon.
A	Tupper, Augustus Maclanchlan.
C	Tupper, John Darrow.
A	Turner, Augustus Walter.
D	Turner, Charles Haverly.
D	Turner, Charles Humphrey.
D	Turner, Edward Lincoln Dwight.
E	Turner, James Henry.
A	Turner, Maurice Worcester.
D	Turner, William George.
D	Tustin, Ruth.
A	Tuttle, Albert Henry.
A	Tuttle, Frances Caroline.
A	Tuttle, George Herman.
A	Tuttle, George Thomas.
A	Tuttle, Karl Rand.
A	Twitchell, Edward Thayer.
A	Twitchell, George Pierce.
A	Twombley, Edward Lambert.
A	Tygesson, Alfred.
A	Tyler, Albert Mason.
A	Tyler, John Bennett.
A	Tyler, Waldo Henry.
D	Tyler, Winsor Marrett.
D	Tyrode, Maurice Paul Octave Vejux.
A	Underhill, Charles Dudley.
D	Underhill, Elizabeth Colden.
E	Underhill, George Herbert.
D	Underhill, Samuel Graham.
A	Underwood, David Gleason.
D	Underwood, Francis Andrew.
A	Underwood, George Baker.
A	Underwood, George Latham.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

E Underwood, Horton Fay.
D Upham, Emily Clark.
D Upton, Charles Louis.
A Urich, John Henry.
C Urie, John Francis.
A Urquhart, John Edwin.
A Utley, Edward Boswell.
A Utley, James.
A Utley, Maurice Howell.
A Valentine, Henry Charles.
D Valentine, John Forrest.
E Valentine, Julius John.
D Vallée, John Edward.
A Van Allen, Harvey Ward.
B Van Alstyne, Seymour March.
D Van Deursen, George Livesey.
D Van Magness, Benjamin, Jr.
E Van Magness, Fred.
D Van Marter, Le Roy John.
A Van Pelt, Gertrude Wyckoff.
D Van Rensselaer, Henry Rensselaer.
D Van Winkle, Peter.
D Vance, Michael E.
A Vander Burgh, David Williams.
A Varney, Edith Charles.
A Varney, Fred Elbridge.
E Varnum, Leavitt R. J.
A Vaughan, Jonas Hobart.
D Verhoff, Frederick Herman.
A Vermilye, Oscar Eugene.
A Verner, Ismael.
D Vickery, Eugene Augustus.
A Vickery, Herman Frank.
A Vickery, Lucia Florence.
D Vieira, José Pacheco.
A Vietor, Agnes Caecilia.
D Vigeant, Joseph Edward.
D Viger, Joseph Edmund Avila.
A Viles, Clarence Albertus.
E Vinal, Charles Renough.
A Vinal, Frank Thomas.
E Vinal, Harry Gardner.
D Vinal, Walter Henry.
D Vincent, Beth.
B Viney, William Henry.
A Virgin, Franklin Pierce.
D Vogel, George Louis.
E Vogel, James Oswald.
D Von Groll, Maximillian Charles.
D Von Sonneberg, Archie Siegfried.
A Vose, Albert Churchill.
D Vose, Robert Henry.
D Voss, John William.
D Vrahnos, Antonios Nicholas.
D Vrooman, Earle Morey.
B Wade, George Washington.
A Wadsworth, Oliver Fairfield.
B Wagner, David.
D Wait, Sheridan Paul.
A Waite, Clarence Howard.
A Waite, Lorenzo.
A Wakefield, Albert Tolman.
B Wakefield, Josiah Judson.
D Walch, Joseph Francis.
D Walcott, Henry Joel, Jr.
A Walcott, Henry Pickering.
B Wales, Edward Clarence.
E Wales, Ernest de Wolfe.
A Walker, Alexander Taylor.
A Walker, Augustus Chapman.
D Walker, David Harold.
A Walker, Frank Clifford.
B Walker, Gustavus Freedom.
A Walker, James Taylor.
A Walker, James William.
D Walker, Lewis Marshall.
E Walker, Mary Wheeler.
A Walker, Thomas Jackson.
D Walker, Wallis Dunlap.
A Walker, William.
D Walker, William Emrich.
D Walker, William Hastings.
D Walker, William Pomp.
C Walkley, William Samuel.
D Wallace, Anna Marie.
A Wallace, Frank Huron.
D Wallace, George Loney.
D Wallace, John.
A Waller, Thomas Gilmore.
D Wallis, Nathaniel.
D Walsh, Charles Francis Adams.
A Walsh, Charles Joseph.
D Walsh, John Edward.
D Walsh, Thomas Emmet.
A Walton, George Lincoln.
D Walton, William Joseph.
E Ward, Edward Silvanus.
D Ward, Frederick Spalding.
A Ward, George Otis.
D Ward, Horace William.
D Ward, Parker Myles.
A Ward, Rollin Clayton.
D Ward, Roy Joslyn.
E Ward, William Greenleaf.
E Warden, Ralph Alexander.
D Wardsworth, Richard Goodwin.
A Wardwell, Percival Goodwin.
A Wares, Abel.
A Warner, Carmillus Turten.
D Warner, Charles Norton.
A Warner, Emerson.
A Warner, Frederick Augustus.
A Warner, Henry.
B Warner, Thomas Jefferson.
D Warren, Alva Harding.
D Warren, Arthur Fay.
D Warren, Edward Dane.
B Warren, Edwin Smith.
A Warren, Ernest Leighton.
D Warren, Franklin Lafayette.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

D	Warren, Henry Stanley.
A	Warren, Herbert.
A	Warren, Hobart Endicott.
A	Warren, John Collins.
A	Warren, John Kelso.
A	Warren, Orin.
D	Warren, William Barnard.
B	Warren, William Marvin.
A	Warren, William Thomas.
A	Warwick, James.
A	Washburn, Elliott.
E	Washburn, Frank Hall.
D	Washburn, Frederic Augustus.
A	Washburn, George Hamlin.
B	Washburn, Vienna Amelia Parsons.
D	Wasson, Watson Lovell.
D	Waterhouse, Henry Edwin.
D	Waterman, George Arthur.
D	Waterman, John Slater.
B	Waters, Samuel William.
D	Watkeys, Frederick William.
B	Watkins, Charles Edward.
A	Watkins, Robert Lincoln.
D	Watkins, Royal Philip.
D	Watson, David Robert.
C	Watson, Francis Sedgewick.
D	Watson, Frank Gilman.
B	Watson, Fred William.
A	Watson, George Henry.
A	Watson, James Maurice.
D	Watson, Walter Linwood.
A	Watson, William Purkis.
A	Watters, William.
D	Watters, William Henry.
A	Wattles-Faunce, Mary Ann.
D	Watts, Harry Adelbert.
A	Watts, Henry Fowler Ransford.
D	Weaver, George Albert.
A	Webb, Mary Elizabeth.
A	Webb, Melville Emerson.
D	Webb, Walter James.
A	Webber, Amos Paterson.
A	Webber, Frank Orland.
C	Webber, Frederick Ward.
A	Webber, George Franklin.
D	Webber, Henry Allen.
A	Webber, Horace Green.
A	Webber, Samuel Gilbert.
D	Webster, Frederick Alonzo.
D	Webster, Fred Paterson.
D	Webster, George.
A	Webster, George Arthur.
A	Webster, Jonathan Edwards.
A	Webster, Joseph Rowe.
D	Weed, George Franklin.
A	Weeks, Charles Tupper.
A	Weeks, Joshua Franklin.
D	Weidner, Calvin.
D	Weil, Edna Helen.
A	Weinerovitch, Nochine.
A	Weinstein, Isaac.
A	Weir, Frank Le Sieur.
D	Weis, Joseph Deutsch.
A	Weiser, Walter Rupert.
D	Welch, David Francis.
A	Welch, Edward John.
D	Welch, Edwin Andrew.
D	Welch, George Oakes.
A	Welch, John Frederick.
D	Welch, Thomas Francis.
A	Weller, Francis Joseph.
F	Wellington, James Lloyd.
D	Welles, Delbert Arthur.
D	Wells, Abner Toothaker.
D	Wells, David Washburn.
A	Wells, Frank.
A	Wells, James Lee.
D	Wells, John Milton.
E	Wennerberg, Francis Joseph.
A	Wentworth, Arthur Howard.
C	Wentworth, Caroline Young.
D	Wentworth, Harry Wilder.
B	Wentworth, Horace.
A	Wentworth, Jacob Brackett.
D	Wentworth, Lowell Franklin.
A	Wentworth, Walter Henry.
D	Wentworth, William Ezekiel.
D	Wentworth, William Parish.
A	Wentworth, William Warren.
A	Werner, Anders Christen.
E	Wernick, Benzion G.
D	Wescott, William Henry.
B	Wesley, Charles Main.
A	Wesley, John Lyman.
A	Wesley, Sarah Jane.
A	Wesselhoeft, Walter.
C	Wesselhoeft, William Fessenden.
C	Wesselhoeft, William Palmer.
D	West, Bertha Helen.
A	West, Edward Graeff.
A	West, George Leon.
B	West, Pliny Hume.
D	Westall, John.
A	Westergren, Frances Clarke.
A	Weston, George Drake.
A	Weston, Isabel Gray.
D	Westwood, Mabel Inez.
A	Wetherbee, Angeline Giles.
D	Wetherbee, Lucy Emma.
A	Wetherbee, Roswell.
A	Wetherbee, Sarah Lucretia.
A	Wetherell, Arthur Bryant.
A	Whalley, Thompson.
A	Wheatley, Frank George.
D	Wheatley, Louis Frederick.
D	Wheaton, James Lucas, Jr.
A	Wheeler, Alfred Augustus.
A	Wheeler, Charles Douglas.
D	Wheeler, Emma Hammond.
E	Wheeler, George Day.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

E	Wheeler, Gilman Avery.
A	Wheeler, Harry Deveraux.
D	Wheeler, James Hudson.
E	Wheeler, Jenness Day.
A	Wheeler, Leonard.
D	Wheeler, Lucia Anna.
A	Wheeler, Morris Plumer.
D	Wheelock, Albert Andrews.
D	Whelpley, George Frederick.
C	Whipple, Albert Lawrence.
A	Whipple, Farrington Hasham.
C	Whipple, Frank Lewis.
A	Whiston, Edward Andem.
A	Whitaker, Clarence Wilder.
A	Whitcombe, Charles Reed.
E	White, Arthur Joseph.
A	White, Belle Joanna Platt.
C	White, Charles James.
D	White, Clifford Allen.
A	White, Edward Forest.
C	White, Emory Lincoln.
D	White, Everett.
D	White, Frank Dunster.
D	White, Franklin Warren.
A	White, George Edwin.
D	White, Henry George.
A	White, Herbert Warren.
A	White, James Clarke.
D	White, Jonathan Hutchings.
A	White, Leon Edward.
A	White, Leonard Darling.
A	White, Levi.
D	White, Michael William.
A	White, Robert.
A	White, Walter Henry.
A	White, William Allen.
E	Whitford, Robert Atwood.
D	Whitehead, Eugenia.
D	Whitehead, Mary Charlotte.
D	Whitehead, Willett William.
A	Whitehill, George Edward.
D	Whiteside, George Shuttuck.
A	Whitford, Andrew Foster.
A	Whiting, George Washington Whitney.
E	Whiting, Nye Clinton.
A	Whiting, Lewis.
A	Whiting, Walter Booth.
B	Whitman, Edson Fobes.
D	Whitman, William Dutcher.
C	Whitmarsh, Willard Francis.
A	Whitmore, Albion Stinson.
A	Whitney, Charles Alvano.
A	Whitney, Charles Melville.
D	Whitney, Chester Field Smith.
A	Whitney, Edward Melville.
D	Whitney, Edward William.
D	Whitney, Harvey Herbert.
D	Whitney, John Augustus.
D	Whitney, Ray Lester.
A	Whitney, William Fiske.
A	Whitney, William Herbert.
D	Whiton, Ross Kittredge.
B	Whittaker, William Austin.
A	Whittemore, Dwight Stanley.
A	Whitten, George Edwin.
D	Whittier, Cordelia Melvina.
A	Whittier, Daniel Brainard.
A	Whittier, Francis Fremont.
B	Whittier, Helen Adelaide.
D	Whittle, John Augustus.
D	Whoriskey, John Joseph.
D	Wiggin, Ralph Cleaves.
D	Wiggin, William Irving.
A	Wight, Daniel Webster.
A	Wight, George Dewitt.
D	Wight, Thomas Henry Toynbee.
D	Wilber, Walter Cranston.
C	Wilbur, Alliston Chester.
B	Wilbur, Ezra Richmond.
A	Wilbur, Hubert Granville.
A	Wilbur, Sarah Mann.
A	Wilcox, Dorvil Miller.
D	Wilcox, Franklin Samuel.
A	Wild, George Warren.
A	Wilder, Raymond Sargent.
A	Wilder, Sarah Elizabeth.
A	Wildes, Adeline Wilkins.
D	Wiley, Harriet Mary.
B	Wilinsky, Adolph.
D	Wilinsky, Charles Francis.
A	Wilkin, Anna Maria.
D	Wilkins, Charles Downes.
D	Wilkins, George Clarence.
A	Wilkins, George Henry.
D	Willard, Frederick Buell.
B	Willard, Mary Antoinette.
D	Williams, Abram Case.
A	Williams, Augustus Gilbert.
B	Williams, Benjamin Barney.
A	Williams, Charles Crosby.
E	Williams, Charles Edward.
C	Williams, Charles Herbert.
A	Williams, Christopher Earle.
B	Williams, Clara Augusta.
D	Williams, Dudley Abeel.
C	Williams, Edward Denison.
A	Williams, Edward Russell.
A	Williams, Edward Tufts.
A	Williams, Frances Elizabeth.
A	Williams, Francis Henry.
C	Williams, Frank Percival.
D	Williams, Frederic Allen.
D	Williams, Frederic Darbey.
A	Williams, Harold.
A	Williams, Harry Augustus.
D	Williams, Harry Edwin.
A	Williams, Henry Clarence.
D	Williams, Hubert Joseph.
D	Williams, Hugh.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Continued.*

A	Williams, Jacob Lafayette.
D	Williams, John Thomas.
A	Williams. Joseph.
D	Williams, Pearl.
D	Williams, Ruby May.
A	Williams, Sara Jane.
B	Williams, Thomas Francis.
D	Williams, Wellington.
D	Williams, Virans Van.
B	Willis, Andrew Everett.
D	Willis, Charles Austin.
E	Willis, Dwight Fletcher.
D	Willis, John Embert.
C	Willis, John Warren.
B	Willis, Josiah Greene.
A	Willis, Reuben.
D	Wilson, Almira Janette.
D	Wilson, George Gordon Byron.
A	Wilson, Georgiana.
A	Wilson, Charles Milo.
A	Wilson, Charles Oscar.
A	Wilson, Darius.
D	Wilson, Erastus Lozier.
C	Wilson, Frederic Newhall.
A	Wilson, George Slocomb.
A	Wilson, Howard Eugene.
E	Wilson, James Cornelius.
D	Wilson, James Johnston.
D	Wilson, John Herbert.
D	Wilson, Louis Thornton.
A	Wilson, Nettie Frances Mosher.
D	Wilson, Robert Browning.
D	Wilson, William Eaton.
D	Wilson, William Henry.
D	Wims, Denis Patrick
E	Winchester, George Wesley.
A	Windsor, Sarah Sweet.
A	Wing, Clifton Ellis.
A	Wing, Edward Payson.
E	Wingersky, Abraham Samuel.
A	Winkler, Joseph Alexander.
A	Winkley, Jonathan Wingate.
A	Winn, Charles Henry.
E	Winner, George Lloyd.
E	Winslow, Benjamin Sabert.
A	Winslow, Edward Smith.
D	Winslow, Frederick Bradlee.
D	Winslow, George Edgar.
A	Winslow, Kenelm.
D	Winslow, William Henry.
D	Winslow, Richard Elliott.
A	Wiswall, Edward Hastings.
A	Witham, Charles Henry.
D	Withee, Frederick Elmarien.
A	Withington, Alfreda Bosworth.
A	Withington, Charles Francis.
A	Witt, Stephen.
A	Witter, Wilbur Fiske.
D	Wix, George Brinton.
D	Wolbach, Simeon Burt.
A	Wolcott, Grace.
B	Wolcott, Joseph Arthur.
A	Wood, Albert.
D	Wood, Duncan McRuar.
A	Wood, Edward Stickney.
A	Wood, Henry Austin.
D	Wood, Isabella Smith.
D	Wood, Henry Walton.
A	Wood, Julia Beard.
D	Wood, Mary Anna.
D	Wood, Nathaniel Knight.
A	Wood, Nelson Mervin.
A	Wood, Norman Perkins.
A	Wood, Rosto Owin.
A	Wood, Stephen Andrew.
A	Woodbury, Charles Edward.
D	Woodbury, Frank Taylor.
A	Woodbury, George Edwin.
D	Woodbury, Herbert Elwell.
A	Woodbury, Louis Augustus.
A	Woodbury, Stillman Philetus.
D	Woodbury, Willard Porter.
A	Woodbury, William Richardson.
D	Woodhead, Raynor.
D	Woodhouse, Alfred.
D	Woodill, Edith Esty.
A	Woodill, George Franklin.
D	Woodman, Alice Stuart.
A	Woodman, Aurin Payson.
A	Woodman, George Sullivan.
A	Woodman, Julia Frances.
A	Woodruff, Morgan Lewis.
D	Woodruff, Richard Allen.
D	Woodruff, William Jessup.
A	Woods, Charles Edwin.
A	Woods, Charles Livingston.
A	Woods, Frank Aylmer.
D	Woods, George Lyman.
A	Woods, Jarvis Uriah.
A	Woods, Jonathan Henry.
C	Woods, Prince Tannatt.
D	Woodward, Charles Todd.
A	Woodward, Johnson Rufus.
A	Woodward, Lemuel Fox.
A	Woodward, Samuel Bayard.
A	Woodworth, Dwight Sidney.
D	Woodworth, Helen Ida.
E	Woodworth, John Dawson Roswell.
E	Wooldridge, Frederick Vanuxem.
A	Woolly, Emma Myrtice.
A	Worcester, Alfred.
A	Worcester, Edward.
A	Worcester, Fitzwilliam Sargent.
A	Worcester, George Waldron.
A	Worcester, John Fonerden.
D	Wormelle, Charles Burton.
E	Worth, Edward Philip.
D	Worthen, Charles Arthur.
D	Worthing, Frank Bertelle.

OFFICIAL LIST OF PRACTITIONERS OF MEDICINE — *Concluded.*

D	Worthington, Arthur Morton.
D	Wose, Alfred Millard.
D	Wren, William Guy.
D	Wright, Charles Sias.
D	Wright, Charles Wardsworth.
C	Wright, Eliphalet.
A	Wright, Erwin.
B	Wright, Frank Edward Kemble.
D	Wright, George Hermann.
A	Wright, Helen La Forest.
A	Wright, James Henry.
A	Wright, John Homer.
A	Wright, Mary Jane.
B	Wright, William.
B	Wunsch, Paulina.
E	Wyer, Harry Gage.
A	Wylie, Ella Rosalind.
C	Wylie, Eugene Cushman.
E	Wyman, Harry Monroe.
A	Wyman, John Lansen.
D	Wynne, Richard.
D	Yager, Granville Lewis.
A	Yale, Charles Henry.
A	Yale, Joseph Cummings.
D	Yale, Leroy Milton.
E	Yardume, Manoug Garabet.
D	Yeaton, George William.
A	Yenetchi, Henry Ainsworth.
D	Yoosuf, Abraham Kevork.
E	York, Herbert Leroy.
A	York, Roger Sherman.
A	Yorke, Albert Daniel.
A	Young, Benjamin Herbert.
A	Young, Charles Sayward.
A	Young, Edgar William.
A	Young, Edmund Sanford.
E	Young, Emma Elizabeth.
D	Young, Ernest Boyen
C	Young, Jonathan Frank, Jr.
A	Young, John Francis.
A	Young, John Franklin.
A	Young, Leyander John.
D	Young, Oscar Cummings.
E	Young, Ralph Randal.
D	Young, Roy Demas.
D	Young, Ward.
D	Youngman, Julia Ross.
E	Yost, John Dixon.
A	Yvon, Jean Baptiste Wilfred.
A	Zabriskie, Frank Hunter.
D	Zabriskie, Fred Templeton.
B	Zannos, George Anast.
D	Zimmermann, Louise Juliet.
D	Ziplinsky, Henry Edward.
A	Ziselman, Max.

PUBLIC DOCUMENT . . . . No. 38.

EIGHTEENTH ANNUAL REPORT

OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN DENTISTRY.

FOR THE YEAR 1904.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1905.

APPROVED BY

THE STATE BOARD OF PUBLICATION.

MEMBERS OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN DENTISTRY,

1904.

JOHN F. DOWSLEY, D.D.S., *President*,	Boston.
GEORGE E. MITCHELL, D.D.S., *Secretary*,	Haverhill.
THOMAS J. BARRETT, D.D.S.,	Worcester.
DWIGHT M. CLAPP, D.M.D.,	Boston.
GEORGE A. MAXFIELD, D.D.S.,	Holyoke.

Commonwealth of Massachusetts.

BOARD OF REGISTRATION IN DENTISTRY, Dec. 31, 1904.

To His Excellency JOHN L. BATES, *Governor of Massachusetts.*

SIR: — In compliance with the requirements of section 6, chapter 137 of the Acts of 1887, establishing a Board of Registration in Dentistry, we have the honor to submit to you the eighteenth annual report, for the year ending Dec. 31, 1904.

The commissions of Dwight M. Clapp, D.M.D., of Boston, and George A. Maxfield, D.D.S., of Holyoke, having expired in April, they were reappointed members of this Board by Your Excellency for three years, and qualified according to law.

At the June meeting of the Board John F. Dowsley of Boston was re-elected president and George E. Mitchell of Haverhill was re-elected secretary.

Meetings for the examination of candidates were held in March, June and October. The result of these examinations is as follows: —

March examination: —		
Number passed on first examination,	41	
Number passed on second examination,	6	
Number passed on third examination,	3	
Number passed on fourth examination,	3	
Number passed on fifth examination,	–	
Number passed on sixth examination,	1	
Total,		54
Number failed on first examination,	33	
Number failed on second examination,	7	
Number failed on third examination,	11	
Number failed on fourth examination,	3	
Number failed on fifth examination,	2	
Number failed on sixth examination,	1	
Number failed on seventh examination,	1	
Number failed on eleventh examination,	1	
Total,		59
Total number examined in March,		113

June examination: —

Number passed on first examination,	31	
Number passed on second examination,	16	
Number passed on third examination,	2	
Number passed on fourth examination,	2	
Number passed on fifth examination,	2	
Number passed on sixth examination,	-	
Number passed on seventh examination,	2	
Total,		55
Number failed on first examination,	23	
Number failed on second examination,	12	
Number failed on third examination,	2	
Number failed on fourth examination,	5	
Number failed on fifth examination,	2	
Number failed on sixth examination,	1	
Number failed on seventh examination,	3	
Total,		48
Total number examined in June,		103

October examination: —

Number passed on first examination,	13	
Number passed on second examination,	9	
Number passed on third examination,	5	
Number passed on fourth examination,	-	
Number passed on fifth examination,	4	
Number passed on sixth examination,	1	
Number passed on seventh examination,	-	
Number passed on eighth examination,	1	
Total,		33
Number failed on first examination,	7	
Number failed on second examination,	13	
Number failed on third examination,	4	
Number failed on fourth examination,	5	
Number failed on fifth examination,	1	
Number failed on sixth examination,	-	
Number failed on seventh examination,	1	
Number failed on eighth examination,	1	
Total,		32
Total number examined in October,		65

Whole number passed for the year 1904,	142
Whole number failed for the year 1904,	139
Whole number examined for the year 1904,	281

Again we desire to call attention to the fact that the law makes no provision for prosecuting offenders, and does not direct the Board to take initiatory action for its enforcement. The Board, however, deems it of the utmost importance that the law should be more generally enforced in the prosecution of unregistered persons practising dentistry in defiance of the dental act.

As at present constituted, the Board has no funds to employ agents to investigate and prosecute such cases, and we would recommend that a sufficient amount be appropriated by the next General Court for this purpose. Unless some special effort is inaugurated to suppress this growing evil, the efficiency of the dental law to protect the public from unskillful and unscrupulous persons will be seriously hampered.

We also recommend, as an additional safeguard to the public, that an amendment to the dental act be made, — that individuals employing unregistered persons be equally guilty and amenable to the law.

During the past year a new evasion of the law has come to the knowledge of the Board. Taking advantage of that provision of the existing law which permits a student of a dental college to perform operations "in the college infirmary, as a part of the regular course," without examination before or a certificate from the Board, certain so-called dental colleges have been organized and incorporated; students are advertised for, — those of prior experience preferred; and these students are expressly employed to practise on the public, ostensibly for the purpose of education, but in reality for the financial profit of the promoters. Under this scheme the students not only work without pay, but pay for the privilege; while the public, without knowledge of the facts, are practised upon and charged in the usual way for the work these students perform.

Commercialism in the profession is a growing evil, and, if this new scheme to evade and escape the penalties of the law proves to be successful in one or two instances, it is sure to spread. The only remedy is by legislation, and this the Board recommends at the earliest date.

The meetings for examinations of candidates during 1905 will be held in Boston, March 8–10, June 21–23, and October 25–27. Special notice of the examinations is published in the dental journals one month preceding each meeting.

The receipts and expenditures of the Board since the last report are as follows: —

RECEIPTS.

Balance in State treasury Jan. 1, 1904,	$35 46
Fees for examinations, March, June and October,	3,290 00
	$3,325 46

EXPENDITURES.

Expenses to Dec. 31, 1904,	2,311 85
Balance in State treasury Jan. 1, 1905,	$1,013 61

JOHN F. DOWSLEY, *President.*
G. EVERETT MITCHELL, *Secretary.*

PUBLIC DOCUMENT . . . . No. 39.

NINETEENTH ANNUAL REPORT

OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN PHARMACY,

FOR THE

YEAR ENDING SEPTEMBER 30, 1904.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1905.

Approved by

The State Board of Publication.

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NAMES OF BOARD AND OFFICERS.

GEORGE M. HOYT, *President.*
CHARLES F. NIXON, *Secretary.*
HENRY ADAMS.
WILLIAM F. SAWYER.
FRED A. HUBBARD.

SIMON B. HARRIS, *Agent.*

Commonwealth of Massachusetts.

REPORT.

To His Excellency JOHN L. BATES, *Governor*.

SIR: — We have the honor to respectfully submit the following report concerning the condition of pharmacy in the State, and of our official acts and financial transactions, during the past year. We think this year has been one of average prosperity among the pharmacists of our State, and that as a rule the financial returns from the drug business in Massachusetts will compare favorably with other States in the Union. The pharmacists of our State are still working along the lines of co-operation and fraternal organization for the purpose of elevating the standard of our business both professionally and commercially. In many sections of our State success has crowned their efforts, while in some parts of the Commonwealth the results obtained have been discouraging, but as a whole the year has been marked by progress, and we think the general conditions are better than one year ago. Results can only be obtained by organization and persistent work, and the measure of success attained in the past should be an encouragement to greater effort in the future.

EXAMINATIONS.

During the past year our examinations have been conducted on the same plan as the previous year, and the tabulated results of the work will be found in the secretary's report. We think it is our duty to again call the attention of all young men who are thinking of adopting pharmacy as their calling to

the necessity of obtaining a thorough preliminary education before entering a drug store to learn the business. The tendency at the present time in all lines, professional and commercial, is toward a higher standard of education. One State (New York) has already adopted a law which provides as a prerequisite to examination before a board of pharmacy, that the candidate must be a graduate of a college of pharmacy. It is a duty which every pharmacist owes to himself, to the public and the young man to refuse to receive any one wishing to learn the business who is not a graduate of a high school. We would most earnestly recommend that every young man, if possible, become a graduate from a college of pharmacy before presenting himself before this Board for examination. We are living in an age when progress is inscribed on every milepost in the world's great highway, and he who would win in the race must be an educated man.

The president of our Board had the honor of being appointed a delegate by Your Excellency to represent the Commonwealth of Massachusetts at the conference of American boards of pharmacy, held at Kansas City, September 5 to 10, under the auspices of the American Pharmaceutical Association. Twenty-seven States were represented at this meeting and much good work was accomplished, which we trust in time will bring about a much-needed change, namely, a uniform pharmacy law for all the States in the Union. The conditions are such at the present time that the certificate of one State is not recognized by another except in a very few cases, and a pharmacist must pass a new examination should he wish to locate in a State other than his own. This is an uncalled-for hardship, especially to registered drug clerks. There should be a uniform standard of examinations, and a certificate of registration should be valid in all States of the Union. At the meeting in Kansas City a permanent organization was formed, to be known as the National Association of Boards of Pharmacy, to meet yearly in conjunction with the American Pharmaceutical Association, the purpose of this association being to provide for interstate reciprocity in pharmaceutical licensure, based upon a more uniform standard of pharmaceutical education and legislation.

Enforcement of the Pharmacy Law.

The statutes provide that as a prerequisite to obtaining a sixth-class license the applicant must obtain from our Board a certificate of fitness, stating that in our opinion he is a fit person to have the same, and that the public good will be promoted by granting such a license; and in connection with the granting of these certificates an unusual amount of work has devolved on our Board this year. In consequence of investigations made by the police authorities in some of the cities and towns of this State, a large amount of evidence was turned over to us, showing beyond a doubt that some druggists, under the guise of a sixth-class license, which gives them the privilege of selling liquor for medicinal, mechanical and chemical purposes only, had been doing a liquor traffic which would place them in the class of liquor dealers rather than pharmacists, and in all such cases we have refused to grant a new certificate. The pharmacists of this State should understand that a sixth-class license does not give them the right to sell all kinds of liquor at all times, in large or small quantities, to any person who may wish to purchase the same, even though they may certify in writing that they wish it for medicinal, mechanical or chemical purposes. A pharmacist has no right to sell to a person he has good reason to believe will use it for a beverage, and when his liquor sales are greater than his drug business he cannot possibly plead as an excuse that he sold only for medicinal purposes. The greatest foe the legitimate, law-abiding pharmacist of to-day has to meet is the man who, under the disguise of a druggist, runs a liquor store. Without any regard for the ethics of our profession he is usually a trade demoralizer, and the honest pharmacist has to meet his unfair competition. He defrauds the State by doing a first-class liquor business under a sixth-class license. A drug store that cannot live without a liquor license has no excuse for being, and should be abolished. In no State of our Union is the pharmacist granted so great a privilege as the druggist of Massachusetts enjoys under the sixth-class license granted him by our laws. The Commonwealth says to him: "It is necessary there should be a place in every community where liquors can

be purchased for medicinal use, and, relying on your character as a man and your standing as a pharmacist, we grant you this privilege to be used for the good of the public." A large majority of the pharmacists of our State are striving to do an honest and legitimate business, and they should insist that the laws regulating the sixth-class license be lived up to.

When the State created the Board of Registration in Pharmacy, it also enacted certain laws for the purpose of regulating the practice of pharmacy, and it is the business of our Board to see that these laws are enforced, and we should be false to our trust if we did not assume the responsibility of seeing that they are obeyed. It is for the best interest of the public and the legitimate pharmacists that the laws should be respected, and the only reply we have to make to those persons who, during the past year, have criticised our official actions and have sought to prevent our doing our duty, is that it is the purpose of this Board to continue as we have done in the past, to enforce the laws under our jurisdiction without fear, prejudice or partiality, and we think in pursuing this course we shall have the sympathy and support of a large proportion of our brother pharmacists in this Commonwealth.

In January of this year a circular letter was sent to every drug store in the State calling attention to violations of the pharmacy law in leaving stores in charge of unregistered men. We recognize that in many of the smaller stores, that are owned and managed in person by the proprietor, who is a registered pharmacist, the amount of business does not admit of hiring a registered clerk at all times of the year; but when the proprietor is away for days and weeks at a time, transacting other business, or on a vacation, such a condition is an unqualified violation of the law and should not be permitted. When such cases have been brought to our attention, we have, through our agent, investigated them and reported the facts to the proper prosecuting officer. Our agent has, in the discharge of his duties, visited all parts of the State, and every complaint that has come to our office has been investigated.

Many requests having been made to our Board to publish, as a part of our annual report, a list of the registered pharmacists engaged in business in this State, we decided to do so

this year, and had a complete list prepared, but the State Board of Publication refused to allow the same to be printed, on the ground that such a list was uncalled-for and an unnecessary expense to the State.

Respectfully submitted,

GEO. M. HOYT, *President.*
C. F. NIXON, *Secretary.*
HENRY ADAMS.
WM. F. SAWYER.
FRED A. HUBBARD.

BOSTON, MASS., Oct. 1, 1904.

It is with sorrow and regret that we part with the services of our colleague, Prof. Charles F. Nixon of Leominster, whose term of office expires October 1 of this year. In this instance, at least, the law which forbids a re-appointment on our Board will work a distinct injury to the cause of true pharmacy in our State, for it will be hardly possible to find a man so eminently fitted to perform the duties which he has so faithfully discharged during the years he has served on our Board. A man of scholarly attainments, a leader in his chosen profession, we have been accustomed to look to him for guidance and counsel. He has given himself generously to the service of the State, serving with earnestness in every duty to which he has been called. During his term of five years he has filled the office of both president and secretary. By reason of his retirement from this Board we part with a true and honored friend and the State loses the services of a faithful officer.

GEO. M. HOYT.
HENRY ADAMS.
FRED A. HUBBARD.

SECRETARY'S REPORT.

Examination Account.

Meetings for examinations have been held on dates and with results as follows: —

1903-1904.	Days.	Examined.	Registered.	Rejected.
October 6, .	1	7	2	5
October 13, .	1	9	5	4
October 20, .	1	10	1	9
October 27, .	1	7	5	2
November 10,	1	10	4	6
November 17,	1	9	3	6
November 24,	1	10	3	7
December 1, .	1	10	6	4
December 8, .	1	9	3	6
December 15,	1	9	6	3
December 29,	1	8	2	6
January 5, .	1	10	3	7
January 12, .	1	10	2	8
January 19, .	1	9	2	7
January 26, .	1	10	5	5
February 2, .	1	10	3	7
February 9, .	1	7	2	5
February 16,	1	8	5	3
February 23,	1	12	4	8
March 1, .	1	11	4	7
March 8, .	1	7	2	5
March 15, .	1	11	2	9
March 22, .	1	9	2	7
March 29, .	1	11	3	8
April 5, . .	1	10	4	6
April 12, .	1	6	-	6
April 26, .	1	9	3	6
May 3, . .	1	8	4	4
May 10, . .	1	9	1	8
May 17, . .	1	9	3	6
May 24, . .	1	11	7	4
May 31, . .	1	10	3	7
June 1, . .	1	12	-	12
June 7, . .	1	12	5	7
June 8, . .	1	12	4	8
June 14, .	1	12	3	9
June 15, .	1	12	4	8
June 24, .	1	12	2	10
June 28, .	1	10	2	8
September 20,	1	9	3	6
September 27,	1	11	5	6
Totals, .	41	397	132	265

Of the 132 certificates granted this year: —

22 passed on	first examination.		3 passed on	eighth examination.	
40 "	second	"	1 "	ninth	"
21 "	third	"	5 "	tenth	"
12 "	fourth	"	1 "	twelfth	"
14 "	fifth	"	1 "	thirteenth	"
5 "	sixth	"	1 "	fourteenth	"
5 "	seventh	"	1 "	fifteenth	"

FINANCIAL STATEMENT FROM OCT. 1, 1903, TO OCT. 1, 1904.

Examinations.

Fees received for the year ending Sept. 30, 1904: —	
For examinations, 257 at $3,	$771 00
For examinations, 141 at $5,	705 00
For duplicate certificates, 5 at $1,	5 00
	$1,481 00
Paid State Treasurer,	$1,481 00

Certificates of Fitness.

Amount received from Oct. 1, 1903, to March 1, 1904, for certificates of fitness to expire April 30, 1904 ($1 each),		$62 00
Cash paid State Treasurer, certificates having been granted,	$47 00	
Fees returned, applications having been rejected or withdrawn,	13 00	
Amount transferred to new account, applications continued for action by the Board,	2 00	
Amount received from March 1, 1904, to Oct. 1, 1904, for certificates of fitness to expire April 30, 1905 ($1 each),		$1,278 00
Cash paid to State Treasurer, certificates having been granted,	$1,161 00	
Fees returned, applications having been rejected or withdrawn,	115 00	
Amount transferred to new account, applications continued for action by the Board,	2 00	

Annual Appropriation for the Board for Year ending Dec. 31, 1904.

Salaries of members,	$2,400 00
Expenses of members,	1,475 00
Agent, salary and expenses,	2,400 00
Stenographer, witness fees, incidental and contingent expenses, including printing of annual report,	1,500 00
	$7,775 00

NOTE. — The financial year of the State ends December 31, while the financial year of the Board ends September 30.

Expenditures of the Board for Year ending Sept. 30, 1904.

	Salary.	Expense.	Total.
George M. Hoyt,	$500 00	$307 80	$807 80*
Charles F. Nixon,	1,000 00	485 52	1,485 52
Henry Adams,	300 00	462 34	762 34
William F. Sawyer,	300 00	51 85	351 85
Fred A. Hubbard,	300 00	80 57	380 57
Simon B. Harris, agent,	1,500 00	693 21	2,193 21
Bessie B. Burroughs, stenographer,	720 00	–	720 00
	$4,620 00	$2,081 29	$6,701 29

Wright & Potter Printing Company,	$272 65	
The Bradstreet Company,	50 00	
Gilman Brothers,	55 61	
Press Clipping Bureau,	25 60	
The E. L. Patch Company,	24 79	
Samuel Ward Company,	20 76	
Henry W. Stone,	20 70	
Bertha Conley,	18 34	
Whitall Tatum Company,	15 25	
New England Telephone and Telegraph Company,	14 55	
J. L. Hammett Company,	10 00	
Remington Typewriter Company,	9 80	
Neostyle Company,	7 20	
William H. Bradford,	7 20	
Sampson Murdock & Company,	6 50	
Pocket Manual Company,	1 00	
J. L. Morse,	1 95	
Belknap & Co.,	1 75	
Dennison Manufacturing Company,	1 60	
Paid for witness fees,	69 75	
Paid for laundry for examination department,	7 38	
Paid for postal supplies,	4 32	
		646 70
		$7,347 99

* Expenses, $102.10, as delegate to the Conference of American Boards of Pharmacy at Kansas City, Mo.

The following registered pharmacists have died during the past year: —

Ames, John N.,	Chelsea.	Marston, Arthur,	Woburn.
Brackett, Charles L.,	Boston.	Martel, Phillas J.,	Fall River.
Bugby, J. L.,	Springfield.	Morgan, Richard E.,	Boston.
Carter, Miles O.,	Lowell.	Nowell, William F.,	Boston.
Emery, Joseph H.,	Lynn.	Saunders, Daniel D.,	Gloucester.
Fisk, Stephen B.,	Upton.	Smith, Warren,	Chicopee.
Garcelon, Harvey S.,	Somerville.	Smith, Frank,	East Bridgewater.
Gates, Edward O.,	Springfield.	Sproat, Clinton,	Taunton.
Goodnow, Elbridge G.,	Stoneham.	Stover, Joseph W.,	Winthrop.
Hollister, William T.,	Westfield.	Vaillancourt, A. F.,	Canada.
Hull, Frederick A.,	Pittsfield.	Whitney, Henry M.,	North Andover.
Hyland, James F.,	Fall River.	Willard, William H.,	Worcester.
Lewis, Edgar,	Boston.	Wood, Everett E.,	Millbury.

Summary for the Year ending Sept. 30, 1904.

Number of meetings held for hearings and miscellaneous business,	22
Number of hearings on applications for certificates of fitness,	149
Number of hearings on violations of the pharmacy law,	18
Number of hearings on applications for reinstatement,	6
Number of hearings on applications for duplicate certificates,	1
Number of certificates suspended for four years,	1
Number of certificates suspended for three years,	2
Number of certificates suspended for two years,	6
Number of certificates suspended for one year,	1
Number of certificates suspended for six months,	2
Number of certificates suspended for three months,	1
Number of certificates suspended for two months,	1
Number of cases continued for sentence,	2
Number of pharmacists reinstated,	3
Number of drug stores doing business in the State,	1,522
Number of drug stores closed during the year,	20
Number of new stores opened during the year,	12
Number of stores found owned by unregistered proprietors,	15
Number of complaints made to the Board investigated,	130
Number of complaints reported for prosecution,	50
Number convicted,	40
Number of cases continued for trial,	8
Number found not guilty,	2
Number imprisoned,	1
Amount of fines imposed,	$2,600
Number of formal complaints made to the Board,	26

C. F. NIXON,
Secretary.

LAWS

RELATING TO

THE PRACTICE OF PHARMACY

IN

MASSACHUSETTS.

1904.

LAWS RELATING TO PHARMACY.

[Chapter 76, Revised Laws.]

Registration of Pharmacists.

Section 10. There shall be a board of registration in pharmacy consisting of five persons, residents of the commonwealth, who shall be skilled pharmacists, and shall have had ten consecutive years of practical experience in the compounding and dispensing of physician's prescriptions, and shall be actually engaged in the drug business. Not more than one member shall have any financial interest in the sale of drugs, medicines and chemicals, and the compounding and dispensing of physician's prescriptions in the same councillor district. One member of said board shall annually in September be appointed by the governor, with the advice and consent of the council, for a term of five years from the first day of October following, and no person appointed after the twenty-fifth day of June in the year eighteen hundred and ninety-nine shall serve as a member of said board for more than five consecutive years.

Section 11. Said board shall meet on the first Tuesday of October in each year at such time and place as it may determine, and shall organize by electing a president and secretary, who shall be members of the board and who shall hold their offices for the term of one year. The secretary shall give to the treasurer and receiver-general a bond with sufficient sureties, to be approved by the governor and council, for the faithful performance of his official duties. The board shall annually hold regular meetings on the first Tuesday of January, May and October, and additional meetings at such times and places as it shall determine.

Section 12.* Each member of the board shall receive five dollars for every day actually spent in the performance of his duties and the amount actually paid by him, not exceeding three cents a mile each way, for necessary travelling expenses in attending the meetings of the board. The bills for such compensation and his incidental and

* See act to establish salaries of members, on page 28.

travelling expenses shall be approved by the board and paid by the commonwealth. So much of the receipts from examinations as may be necessary for the compensation and expenses of the board may, in addition to any amount authorized by the general court, be used for such purpose.

SECTION 13. The board shall keep a record of the names of all persons examined and registered hereunder and of all money received and disbursed by it, and a duplicate thereof shall be open to inspection in the office of the secretary of the commonwealth. Said board shall annually, on or before the first day of January, make a report to the governor and council of the condition of pharmacy in the commonwealth, of all its official acts during the preceding year and of its receipts and disbursements.

SECTION 14. A person who desires to do business as a pharmacist shall, upon payment of five dollars, be entitled to examination, and if found qualified shall be registered as a pharmacist and shall receive a certificate signed by the president and secretary of said board. Any person who fails to pass such examination shall upon request be re-examined after the expiration of three months at any regular meeting of the board, upon the payment of three dollars. All fees received by the board shall be paid by its secretary into the treasury of the commonwealth.

SECTION 15. Every person who has received a certificate of registration from the board shall conspicuously display the same in his place of business.

SECTION 16. The board shall hear all applications by registered pharmacists for the granting of sixth class licenses, if a hearing is requested by the applicant, and all complaints made to them against any person registered as a pharmacist charging him in his business as a pharmacist with violating any of the laws of the commonwealth, the enforcement of which is under the supervision of the board of registration in pharmacy, and especially of the laws relating to the sale of intoxicating liquors; or engaging with, or aiding or abetting, another in the violation of said laws; or, if he himself is not the owner and actively engaged in such business, with suffering or permitting the use of his name or certificate of registration by others in the conduct of the business of pharmacy. Such complaint shall set out the offence alleged and be made within fifteen days after the date of the act complained of. The board shall notify the person complained against of the charge against him and of the time and place of the hearing at which he may appear with his witnesses and be heard by counsel. Three of the members of the board shall be a quorum for such hearing. Witnesses at hearings before such board

shall testify under oath and may be sworn by a member of the board. The board shall have power to send for persons and compel the attendance of witnesses at said hearings.

SECTION 17. If the full board sitting at such hearing finds the person guilty, the board may suspend the effect of the certificate of his registration as a pharmacist for such term as the board fixes, but the license or certificate of registration of a registered pharmacist shall not be suspended for a cause punishable by law until after his conviction by a court of competent jurisdiction.

SECTION 18. Whoever, not being registered as aforesaid, retails, compounds for sale or dispenses for medicinal purposes or keeps or exposes for sale drugs, medicines, chemicals or poisons, except as provided in section twenty-three, shall be punished by a fine of not more than fifty dollars. But the provisions of this section shall not prohibit the employment of apprentices or assistants under the personal supervision of a registered pharmacist.

SECTION 19. The board shall investigate all complaints of the violation of the provisions of sections ten to twenty-three, inclusive, and report the same to the proper prosecuting officers, and especially investigate and cause to be prosecuted all violations of sections twenty-one to twenty-nine, inclusive, of chapter one hundred.

SECTION 20. The board of registration in pharmacy may annually expend not more than two thousand dollars in the performance of its official duties.

SECTION 21. A registered pharmacist against whom a complaint or charge is pending before the board, or his counsel, shall have the same right of access to documents in the possession of said board as a person who is charged with crime in the courts of the commonwealth would have to documents in the possession of the clerk of the court or of the prosecuting officer.

SECTION 22. The court or magistrate before whom a person is convicted of a violation of section twenty-six of chapter seventy-five, of section eighteen of this chapter, of sections twenty-five, twenty-six, twenty-seven of chapter one hundred or of section two of chapter two hundred and thirteen shall send to the board of registration in pharmacy a certificate under seal showing the time, cause and place of conviction.

SECTION 23. The provisions of sections twenty-one to twenty-nine, inclusive, of chapter one hundred, section twenty-six of chapter seventy-five and section two of chapter two hundred and thirteen shall not apply to physicians who put up their own prescriptions or dispense medicines to their patients; nor to the sale of drugs, medicines, chemicals or poisons at wholesale only; nor to the manufacture

or sale of patent and proprietary medicines; nor to the sale of non-poisonous domestic remedies usually sold by grocers and others; nor shall any unregistered member of a copartnership be liable to the penalties hereof if he retails, compounds for sale or dispenses for medicinal purposes drugs, medicines, chemicals or poisons only under the personal supervision of a registered pharmacist. The widow, executor or administrator of a registered pharmacist who has died or the wife of one who has become incapacitated may continue his business under a registered pharmacist.

[CHAPTER 100, REVISED LAWS.]

LAWS AND CONDITIONS RELATIVE TO DRUGGISTS' LIQUOR LICENSE.

SECTION 16. The licensing board may at any time refuse to issue a license to a person whom it considers unfit to receive the same; but the provisions of this chapter shall not be so construed as to compel said licensing board to grant licenses.

SECTION 17. Each license shall be expressed, to be subject to the following conditions: —

First, That the provisions in regard to the nature of the license, and the building in which the business may be carried on under it, shall be strictly adhered to.

Second,* That spirituous or intoxicating liquors shall not be sold between the hours of eleven at night and six in the morning or on the Lord's day; but if the licensee is also licensed as an innholder he may, between the hours of six in the morning and eleven at night on the Lord's day, supply such liquors to guests who have resorted to his inn for food or lodging.

Third, That spirituous or intoxicating liquor shall not be sold, exchanged or delivered, or exposed, offered or kept for sale, exchange or delivery, upon the licensed premises, unless it is of good standard quality and is free from any adulteration prohibited in the Pharmacopoeia of the United States or by the laws relative to adulteration of drugs and food, for either a food or a drug. If it is marked, labelled or represented as being the product of any foreign country, it shall also be of the standard quality required for its legal sale for domestic use in the country of its reputed production. All such liquors which are sold, exchanged or delivered, or which are exposed or kept for sale, exchange or delivery, under a license of the sixth class, shall be of the quality required for their sale as drugs under the provisions of the laws relative to the adulteration of drugs and food.

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* See section 25.

Fourth, That liquor shall not be sold or delivered on the licensed premises to a person who is known to be a drunkard, to an intoxicated person, or to a person who is known to have been intoxicated within the six months last preceding, or to a minor, either for his own use, the use of his parents or of any other person, or, unless upon the prescription of a duly registered physician, to a person known to have been supported in whole or in part by public charity at any time during the twelve months last preceding the date of the license.

Fifth, That there shall be no disorder, indecency, prostitution, lewdness or illegal gaming on the licensed premises or on any premises connected therewith by an interior communication.

Sixth, That the license, or a copy thereof certified by the recording officer of the licensing board or by the clerk of the city or town by which it is issued, shall be displayed on the premises, in a conspicuous position, where it can easily be read.

Seventh, That the license shall be subject to forfeiture, as herein provided, for breach of any of its conditions; and that, if the licensee is convicted of a violation of any of such conditions, his license shall thereupon become void.

Each license of the first five classes shall be subject to the further condition that the licensee shall not sell, give away or deliver on the licensed premises any intoxicating liquors on a legal holiday as defined in section five of chapter eight or on any day on which a national, state, city or annual town election is held in the city or town in which the licensed premises are situated, except the day of an election in a city if such election is not required to be held in the ward in which the licensed premises are situated; but this condition shall not apply to a wholesale druggist who, on the day of an election as aforesaid, sells, gives away or delivers intoxicating liquors on the licensed premises, nor to an innkeeper who sells, gives away or delivers in his inn any intoxicating liquor to a guest who has resorted to his inn for food or lodging; but an innkeeper shall not upon such holiday sell, give away or deliver intoxicating liquor in his inn under a fourth or fifth class license.

. . . .

SECTION 21. Druggists and apothecaries may sell pure alcohol for medicinal, mechanical or chemical purposes; and wholesale druggists and apothecaries may also sell liquor of any kind, not to be drunk on the premises, under a license of the fourth class.

SECTION 22. No license for the sale of spirituous or intoxicating liquor, except of the sixth class, shall be granted to retail druggists or apothecaries. One or more licenses of the sixth class shall be granted annually by the licensing board of cities, or by the mayor

and aldermen of cities having no such board, or by the selectmen of towns, to retail druggists or apothecaries who are registered pharmacists actively engaged in business on their own account, upon presentation to the licensing board of the certificate of fitness prescribed by the following section, if it appears that the applicant is a proper person to receive such license, and is not disqualified to receive it under the provisions of sections fifty-three and fifty-four. A registered pharmacist who owns stock of the actual value of at least five hundred dollars in a corporation which has been incorporated for the purpose of carrying on the drug business, and who conducts in person the business of a store of such corporation, shall be considered as actively engaged in business on his own account and as qualified to receive a license for such store.

SECTION 23. The board of registration in pharmacy may, upon the payment by an applicant for a license of the sixth class of a fee of not more than one dollar, issue to him a certificate, which shall not be valid after one year from its date, stating that in the judgment of said board he is a proper person to be entrusted with such license and that the public good will be promoted by the granting thereof. Any registered pharmacist against whom no complaints have been made to said board may be considered a proper person to receive such certificate. If complaint is made, it shall state in writing the reason why a certificate should be withheld.

SECTION 24. A license of the sixth class shall become null and void without any process or decree, if the registered pharmacist to whom it has been granted ceases to conduct his business in person and on his own account, or upon the revocation of his certificate of registration as a pharmacist, unless the registered pharmacist has become unable to so conduct his business or has died, and his business is continued by his wife, widow, executor or administrator under another registered pharmacist.

SECTION 25. Retail druggists and apothecaries shall not sell intoxicating liquor of any kind for medicinal, mechanical or chemical purposes except upon the certificate of the purchaser, which shall state the use for which it is wanted, and which shall be immediately cancelled at the time of sale in such manner as to show the date of cancellation. They shall not, when making such sales upon the prescription of a physician, be subject to the provisions of the second clause of section seventeen.

SECTION 26. Every retail druggist and apothecary shall keep a book in which he shall enter, at the time of every such sale, the date thereof, the name of the purchaser, the kind, quantity and price of said liquor, the purpose for which it was sold, and the residence by

street and number, if there be such, of said purchaser. If such sale is made upon the prescription of a physician, the book shall also contain the name of the physician and shall state the use for which said liquor is prescribed and the quantity to be used for such purpose, and shall be cancelled in the manner before provided with reference to certificates. Said book shall be in form substantially as follows: —

Date.	Name of Purchaser.	Residence.	Kind and Quantity.	Purpose of Use.	Price.	Name of Physician.

The certificate mentioned in the preceding section shall be a part of said book and shall not be detached therefrom, and shall be in form substantially as follows: —

Certificate.

I wish to purchase____________________
and I certify that I am not a minor and that the same is to be used for * Mechanical * Chemical * Medicinal purposes. [* Draw a line through the words which do not indicate the purpose of the purchase.]

Signature____________________

Cancelled____________________

SECTION 27. The book, certificates and prescriptions provided for in the two preceding sections and the book provided for in section thirty-two shall at all times be open to the inspection of the licensing board in cities having such boards and in all other cities and towns, to the inspection of the mayor and aldermen, selectmen, overseers of the poor, sheriffs, constables, police officers and justices of the peace.

SECTION 28. Whoever makes or issues a false or fraudulent certificate or prescription referred to in sections twenty-five and twenty-six shall be punished by a fine of ten dollars.

SECTION 29. Whoever, not being a registered pharmacist, procures a sixth class license for the sale of intoxicating liquors in the name of a registered pharmacist who is dead, or in the name of a registered pharmacist by borrowing, hiring or purchasing the use of his certificate, and who, being himself the owner or manager of the place, shall himself or by his servants sell intoxicating liquor, shall be punished by a fine of not less than fifty nor more than five hundred dollars, and by imprisonment for not less than one nor more than six months. The provisions of section ten of chapter two hundred and twenty shall not apply to such sentence.

. . . .

SECTION 44. Licensing boards may transfer licenses from one location to another within the city or town in which such licenses are in force; but such transfer shall be granted only to the original licensee, and like notice shall be given, the same provisions shall apply, and other proceedings shall be the same as are required upon the granting of licenses, except that no new license fee shall be required.

[CHAPTER 213, REVISED LAWS.]

OF CRIMES AGAINST THE PUBLIC HEALTH.

SECTION 2. Whoever sells arsenic (arsenious acid), atropia or any of its salts, chloral hydrate, chloroform, cotton root and its fluid extract, corrosive sublimate, cyanide of potassium, Donovan's solution, ergot and its fluid extract, Fowler's solution, laudanum, McMunn's elixir, morphia or any of its salts, oil of pennyroyal, oil of savin, oil of tansy, opium, Paris green, Parsons' vermin exterminator, phosphorus, prussic acid, "rough on rats," strychnia or any of its salts, tartar emetic, tincture of aconite, tincture of belladonna, tincture of digitalis, tincture of nux vomica, tincture of veratrum viride, or carbolic acid, without the written prescription of a physician, shall affix to the bottle, box or wrapper containing the article sold a label of red paper upon which shall be printed in large black letters the name and place of business of the vendor and the words *Poison* and *Antidote*, and the label shall also contain the name of an antidote, if any, for the poison sold. He shall also keep a record of the name and quantity of the article sold and of the name and residence of the person or persons to whom it was delivered, which shall be made before the article is delivered and shall at all times be open to inspection by the officers of the district police and by the police authorities and officers of cities and towns; but no sale of cocaine or its salts shall be made except upon the prescription of a physician. Whoever neglects to affix such label to such bottle, box or wrapper before delivery thereof to the purchaser or whoever neglects to keep or refuses to show to said officers such record or whoever purchases any of said poisons and gives a false or fictitious name to the vendor shall be punished by a fine of not more than fifty dollars. The provisions of this section shall not apply to sales by wholesale dealers or manufacturing chemists to retail dealers, or to a general merchant who sells Paris green, London purple or other arsenical poisons in unbroken packages containing not less than one-quarter of a pound, for the sole purpose of destroying potato bugs or other insects upon plants, vines

or trees, except that he shall record each sale and label each package sold, as above provided.

SECTION 3. Whoever sells a cigarette to a person under eighteen years of age, or whoever sells snuff or tobacco in any of its forms to a person under sixteen years of age, or, not being his parent or guardian, gives a cigarette to a person under eighteen years of age, or gives snuff or tobacco in any of its forms to a person under sixteen years of age, shall be punished by a fine of not more than fifty dollars.

SECTION 4. Whoever sells to a person under sixteen years of age any candy or other article enclosing liquid or syrup containing more than one per cent of alcohol shall be punished by a fine of not less than fifty nor more than one hundred dollars.

[CHAPTER 321, ACTS OF 1902.]

AN ACT TO AUTHORIZE THE BOARD OF REGISTRATION IN PHARMACY TO RECONSIDER ITS ACTION IN CASES WHERE IT MAY HAVE SUSPENDED OR REVOKED THE LICENSE OR CERTIFICATE OF REGISTRATION.

Be it enacted, etc., as follows:

SECTION 1. Section seventeen of chapter seventy-six of the Revised Laws is hereby amended by inserting after the word "suspended," in the fifth line, the words: — or revoked, — and by adding at the end thereof the words: — The board may at any time in its discretion reconsider its action in cases where it has suspended or revoked the license or certificate of registration of a pharmacist, and may change its determination as justice shall require, — so as to read as follows: — *Section 17.* If the full board sitting at such hearing finds the person guilty, the board may suspend the effect of the certificate of his registration as a pharmacist for such term as the board fixes, but the license or certificate of registration of a registered pharmacist shall not be suspended or revoked for a cause punishable by law until after his conviction by a court of competent jurisdiction. The board may at any time in its discretion reconsider its action in cases where it has suspended or revoked the license or certificate of registration of a pharmacist, and may change its determination as justice shall require.

SECTION 2. This act shall take effect upon its passage. [*Approved April 18, 1902.*

[CHAPTER 505, ACTS OF 1902.]

AN ACT TO ESTABLISH THE SALARIES OF THE MEMBERS OF THE BOARD OF REGISTRATION IN MEDICINE, THE BOARD OF REGISTRATION IN PHARMACY AND THE BOARD OF REGISTRATION IN DENTISTRY.

Be it enacted, etc., as follows:

SECTION 1. The secretary of the board of registration in medicine shall receive a salary of twenty-five hundred dollars a year, and the other members of the said board shall each receive a salary of three hundred dollars a year.

SECTION 2. The secretary of the board of registration in pharmacy shall receive a salary of one thousand dollars a year, and the other members of said board shall each receive a salary of three hundred dollars a year, except that the chairman of said board shall receive a salary of five hundred dollars.

SECTION 3. The chairman and secretary of the board of registration in dentistry shall each receive a salary of four hundred dollars a year, and the other members of said board shall each receive a salary of two hundred dollars a year.

SECTION 4. Each member of the boards mentioned in sections one, two and three shall receive in addition to his salary his necessary travelling expenses actually incurred in attending the meetings of the board. The salaries and expenses of the members of the board of registration in medicine, the board of registration in pharmacy and the board of registration in dentistry shall be paid out of the treasury of the Commonwealth.

SECTION 5. The fees received for examination and registration of applicants before the board of registration in medicine, before the board of registration in pharmacy, and before the board of registration in dentistry, shall be paid monthly by the secretaries of the respective boards into the treasury of the Commonwealth.

SECTION 6. Sections four, twelve and twenty-seven of chapter seventy-six of the Revised Laws are hereby repealed.

SECTION 7. This act shall take effect on the first day of July in the year nineteen hundred and two. [*Approved June 23, 1902.*

[Chapter 49, Acts of 1904.]

AN ACT MAKING APPROPRIATIONS FOR THE BOARD OF REGISTRATION IN PHARMACY.

Be it enacted, etc., as follows:

Section 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the Commonwealth from the ordinary revenue, for the board of registration in pharmacy, for the year ending on the thirty-first day of December, nineteen hundred and four, to wit: —

For the salaries of the members of the board, twenty-four hundred dollars.

For travelling and other expenses of the members of the board, a sum not exceeding fourteen hundred and seventy-five dollars.

For the salary and expenses of the agent of the board, a sum not exceeding twenty-four hundred dollars.

For a stenographer, witness fees, and for incidental and contingent expenses of the board, including the printing of the annual report, a sum not exceeding fifteen hundred dollars.

Section 2. This act shall take effect upon its passage. [*Approved February 6, 1904.*]

WESTON RESERVOIR — View from Ash Street looking towards Screen Chamber at Outlet.

PUBLIC DOCUMENT . . . . No. 57.

FOURTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND SEWERAGE BOARD.

JANUARY 1, 1905.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1905.

Approved by

The State Board of Publication.

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the calendar year ending December 31, 1904, and now presents a detailed statement of the operations for the year, being its

FOURTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) Board, Officers and Employés.

The membership of the Board has continued the same as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and executive officer of the Board, and Alfred F. Bridgman as auditor and purchasing agent.

The administrative office force, during the early part of the past year, consisted, in addition, of the same number of employés as in the preceding year; but during the year considerable reduction has been made, and the force now comprises a book-keeper, an assistant book-keeper, an assistant in auditing, a paymaster, one general clerk, four stenographers, a telephone operator, one messenger, and a janitor with two assistants, one of whom acts as watchman. It has been determined in the coming year to place the auditing department under the general supervision of the secretary, the present auditor acting as purchasing agent.

Alfred C. Vinton continued as conveyancer during the first half of the year, a position which he had filled efficiently since the organization of the Water Board. Owing to the diminution in the amount of conveyancing, he severed his connection with the Board on July 1, 1904, and since that date George D. Bigelow, who had acted as assistant conveyancer, has been in charge, assisted by Miss Alline E. Marcy, title examiner, and by one stenographer.

Frederic P. Stearns has continued as Chief Engineer of the Board, with special charge of the Water Works. Joseph P. Davis and Hiram F. Mills are retained to act as consulting engineers when their services are required.

The various departments of the Water Works have been, subject to the Chief Engineer, in charge of the following: Dexter Brackett, Engineer of the Distribution Department, and, since March 10, also in charge of the Sudbury Department; Thomas F. Richardson, Engineer of the Dam and Aqueduct Department; Charles E. Wells, Engineer of the Reservoir Department; Frank T. Daniels, Principal Office Assistant. Horace Ropes was Engineer of the Weston Aqueduct Department until May 25, when this department was abolished and the duties were transferred to the Distribution Department.

The engineering force employed on the Water Works, both in construction and maintenance, has, upon the average during the year, comprised, in addition, 10 division engineers, 16 assistant engineers, and others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, to the number of 101, — in all, 127. The maximum engineering force employed at any one time during the year on construction and maintenance was 148.

There have also been employed inspectors, other than engineering inspectors, to the maximum number of 11. Day-labor forces under the general supervision of the engineers and the immediate direction of foremen, varying in numbers from time to time, have been employed in pipe laying, in general improvements and repairs, and in minor operations.

In addition, a maintenance force, numbering, upon the average during the year, 202, has been required at the pumping stations and upon the reservoirs, aqueducts, pipe lines and other works. This force at the end of the year numbered 216, and was distributed

among the various departments as follows: Sudbury and Distribution Departments, 203; Dam and Aqueduct Department, 12; Reservoir Department, 1.

The maximum number of men employed upon contracts by the various contractors upon the Water Works during the year was for the week ending June 11, when the number amounted to 1,627.

William M. Brown, Engineer of the Sewerage Works, has been in charge of both construction and maintenance upon these works.

He was assisted during the larger part of the year by 2 division engineers who were in charge of the various sections of sewer construction, 1 division engineer in charge of drafting room and records, 6 assistant engineers, 6 inspectors, and 22 others, who were employed in various engineering capacities, and as clerk, stenographer and messenger in the department. The maximum engineering force employed at any one time during the year on construction and maintenance of the Sewerage Works was 37.

Day-labor forces, under the general supervision of the engineers and the immediate direction of foremen, have been employed on the High-level Sewer in grading the roads and grounds about the Ward Street pumping station, in connecting the Charles River valley sewer with the High-level Sewer, and in grading and filling on Nut Island, in Quincy. On the North Metropolitan System, day-labor forces have been employed in the construction of parts of sections 61 and 62 of the Revere extension in Chelsea and in minor work.

The maximum number of men employed upon contracts by the various contractors and upon day-labor construction upon the Sewerage Works during the year was for the week ending July 24, when the number amounted to 302.

Upon the completion of construction on both the North and South Metropolitan systems, the engineering force was reduced to 9, all of whom are now employed in maintenance of the works.

The regular maintenance force required for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of engineers and day-labor construction forces before enumerated, has upon the average numbered 90. The opening of the High-level Sewer and putting into operation of the Ward Street pumping station and Nut Island screen-house late in the year necessitated an increase in the force,

which at the end of the year numbered 125, of whom the engineer in charge and 9 assistants and draftsmen were engaged in general upon the works, and of the remainder, 72 were employed upon the North System and 43 upon the South System.

(2) Offices and Buildings.

The office of the Metropolitan Water and Sewerage Board is in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in which are also located the offices of the secretary and auditor and the conveyancer, and the main engineering offices of both the Water Works and the Sewerage Works.

The headquarters of the Wachusett Reservoir and Wachusett Dam and Aqueduct departments of the Water Works have been maintained in the office building in Clinton. Branch offices of the Reservoir Department have been maintained, two in West Boylston and one in Oakdale. A branch office of the Dam and Aqueduct Department has been maintained at the Wachusett Dam. The main office of the Weston Aqueduct Department in Saxonville was discontinued on June 30, and the branch office located in Wayland was discontinued on February 29, and that in Weston on July 16. Headquarters of the Distribution Department have been maintained in the central office in Boston. For the Sudbury Department an office has been maintained at South Framingham. Branch headquarters of the maintenance force of the Water Works in the northern part of the District have been in buildings in the Glenwood pipe yard in Medford, where there are offices, shops, store rooms and stables; and the maintenance force for the southern part of the District has headquarters in buildings at the Chestnut Hill Reservoir.

Maintenance in connection with the Water Works has embraced the care and operation of the Chestnut Hill high-service and low-service pumping stations; the Spot Pond, Arlington and West Roxbury pumping stations; the Clinton sewerage pumping station at Clinton; the Pegan Brook pumping station at Natick; the Mystic pumping station at Medford, not now in active operation; the Wachusett Reservoir; Lake Cochituate; the Sudbury Reservoir and the various smaller reservoirs in the Sudbury watershed; Spot Pond, Chestnut Hill Reservoir and the smaller distributing reservoirs in different portions of the District; the Cochituate, Sudbury, Wachusett and Weston aqueducts; as well as the various gate-houses,

siphon and terminal chambers and other structures connected with the several reservoirs and aqueducts, dwellings for attendants, and various other buildings for operating purposes.

There were maintained, in connection with the construction of the Sewerage Works, branch engineering offices at Hough's Neck and Roxbury; an office for a portion of the year at Chelsea; and, in addition, seven portable booths were in use along the line of the work. For the maintenance of the Sewerage Works there are operated the Deer Island, East Boston, Charlestown, Alewife Brook, Ward Street and Quincy pumping stations, the Nut Island screen-house, the North Metropolitan Sewer and its extensions, and the Charles River valley, Neponset valley and High-level sewers. Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained at the East Boston and Ward Street pumping stations and at the stockyard at Hough's Neck.

(3) Conveyancing.

During the earlier portion of the year many claims for damages to real estate were settled, so that a large amount of conveyancing work was required in the way of examining the records, bringing up to date the titles at the registry of deeds, and the preparation and drafting of deeds and other necessary instruments.

The total number of cases settled during the year was 73, of which 68 were on account of Water Works, and affected 734.345 acres of land, and 5 on account of Sewerage Works, affecting 1.121 acres.

In addition, examinations of titles and the preparation of papers were required on account of various questions affecting lands which had been acquired from the city of Boston, and of various other claims which arose with reference to lands of the Commonwealth. The number of titles, therefore, which have been actually examined, and the questions relating thereto which required the preparation of various instruments, were much greater than the number above indicated.

In addition, also, there have been drafted 3 instruments of takings, embracing 127.50 acres, 2 on account of the Water Works and 1 on account of the Sewerage Works; and 13 deeds of lands and releases of rights in lands have been called for, and many papers in the nature of leases, licenses and forms of contract have been drafted.

Besides the work that has been done especially for the Board,

many reports on titles have been called for by the Attorney-General for use in the preparation of suits and for the information of the Attorney-General's Department.

The hearings which have been had in the suits of the cities of Malden, Medford and Melrose against the Commonwealth, on account of the taking of Spot Pond and the various lands adjoining and contiguous thereto, have involved protracted examinations of records and reports and opinions upon titles. Investigation of the titles and history of the lands covered by Spot Pond, and the adjacent lands used in connection therewith, has extended from the beginning of legislative grants and registry records down to the present date; and this examination has required not only investigations at the registry of deeds, but also in the Massachusetts Archives, the histories of the various cities and the genealogies of the early settlers.

A detailed statement of the various takings and settlements is given hereafter.

II. WATER WORKS — CONSTRUCTION.

The amount expended for construction, including real estate acquired and payment of claims, on account of the Water Works during the year 1904, was $2,174,498.19. Of this amount, $1,506,803.38 was expended on account of the Wachusett Dam and Reservoir; $216,740.74 on account of the Weston Aqueduct and Reservoir; $40,554.03 for the improvement of the Wachusett watershed; $39,481.28 for diversion of water; $327,527.62 on account of the taking of Spot Pond; and the remainder, $43,391.14, upon various other operations on the works. The total amount expended for construction since the beginning of the works in the year 1895 has been $38,388,255.76.

(1) Wachusett Dam and Reservoir.

(a) *Wachusett Dam.*

The work upon the Wachusett Dam during the past year has included not only the carrying up in height of the main structure, but also the continuation of the excavations and building into the banks at each end of the dam, so that the ends as well as the foundations shall be embedded in the rock. At the end of the preceding year the masonry had reached an average elevation of 345

WACHUSETT DAM AND POWER AND GATE HOUSE AT END OF 1904.

feet, and during the year 1904 an average elevation has been reached of 396 feet, above the Boston City Base, — an elevation which is 130 feet above the original river bed, and 188 feet above the lowest point of the foundation. This average elevation is 1 foot above the full-reservoir level, and there consequently remain, upon an average, but 19 feet more in height to be added.

The length of the dam has been extended from 739 feet to 1,024 feet, exclusive of the waste-weir, which is 452 feet in length. During the year 59,900 cubic yards of earth and 36,810 cubic yards of rock have been excavated. The stone masonry has amounted to 82,333 cubic yards. There have been used in the work during the year 16,561 barrels of Portland cement and 61,739 barrels of natural cement.

The abutment, so called, at the easterly end of the dam near Boylston Street, has been in like manner carried up, and the bastion at the westerly end, which divides the dam from the waste-weir, has been built nearly to the proper height. The most of the masonry work upon the waste-weir has been completed, and all but a small portion of the waste channel, which extends along the ledge from the weir to the river below the dam, a distance of about 1,240 feet, has been excavated and made ready for use. A granite arch bridge about 131 feet long, and having a span of 35 feet 6 inches, has been constructed across the lower end of the channel, which will afford access to the dam on the westerly side of the river.

The substructure, containing the gates and valves for the lower gate-chamber, was built in the preceding year, but during the past year the superstructure has been erected. This is a building 104 feet 6 inches long, 74 feet wide, and having a height of about 59 feet above the ground. The greater part of the interior is made up of one large room, in which will be installed the necessary machinery for the production of power. There are in addition several smaller rooms, which will be used for the various purposes needed in connection with the operation of the works. The exterior walls are from the same stone quarry from which the ashlar stone for the dam has been obtained.

The upper gate-chamber is built within the main structure of the dam itself, the water being introduced at ports or openings in the walls, and conveyed through sluice-gates by 48-inch pipes through the structure of the dam.

Much work has been accomplished in the grading of the banks along the river below the dam, and in depositing soil both upon the banks and the grounds at the foot of the dam and around the pool. The foundations have also been laid for the various drives and paths leading to the dam.

The work upon the dam has so far advanced that there seems but little doubt that it may be completed during the coming year.

(*b*) *Wachusett Reservoir.*

The building of the Wachusett Reservoir has progressed favorably during the past year. A total of 1,115,341 cubic yards of soil was removed from the bed of the reservoir, and 621 acres of land were stripped. It was estimated that in all, the soil was to be removed from 4,200 acres to the extent of about 6,900,000 cubic yards, and there have been excavated since the beginning of the work to the present date 6,760,405 cubic yards of soil from 3,857 acres. Of the total amount of soil, about 98 per cent. has been removed, and there remain to be stripped about 343 acres.

A large amount of the soil which has been removed, as in previous years, has been carried and deposited in the embankment of the North Dike; but a larger portion has been deposited at different places on the margin of the reservoir, for the purpose of avoiding shallow flowage, and also considerable amounts of soil have been used for the building of the South Dike and for highway embankments. The larger amount of the stripping done has been performed near the upper end of the reservoir in West Boylston, but the soil has also been removed from considerable tracts in Boylston as well as in Clinton and Sterling.

As arrangements have been made by which it may be possible to flow the reservoir during the early part of the present year to elevation 375, the grass and weeds which have grown in the area already cleared have been removed and burned, and a final cleaning has been made of the reservoir bottom to the elevation named. The number of acres thus cleared and made ready for flowing is estimated to be about 3,681.

Additional soil for the completion of the North Dike has been deposited during the year, and the placing of riprap on the slopes toward the reservoir has been completed. The dike has an entire length of 11,100 feet. More than 5,700,000 cubic yards of mate-

rial have been used in the construction of the dike, and 139,000 cubic yards of riprap have been laid upon the water slopes. The cost of the dike has been substantially $750,000.

The South Dike has been entirely constructed during the year, except a portion of the riprapping. This dike has a length of about 2,925 feet, and has been constructed in a manner similar to that in which the North Dike was built. The soil removed from the reservoir has been placed to form the dike, the cut-off trench has been excavated and refilled with compacted material, and the water slopes have been riprapped in part. The cut-off trench was excavated to a maximum depth of 28.5 feet. The material used in the construction of the South Dike has amounted to 418,904 cubic yards of earth, soil and rock, and 7,687 cubic yards of riprap.

The number of buildings in West Boylston removed from the reservoir site during the year was 12, which embraced 2 churches, 6 dwellings, 2 barns, a hall and a store. The total number of buildings removed prior to the year was 259. In the town of Boylston there were removed 8 dwelling houses, a barn and a schoolhouse, — a total of 10 buildings. A few more buildings are still to be removed, but the work of demolition has been nearly completed.

The two nurseries, one upon the north side and the other upon the south side of the reservoir, have been maintained. These nurseries contain upwards of 700,000 seedlings and plants. The larger number of these are white pines and arbor vitæ, but there are many sugar maples, spruces and Scotch pines and smaller numbers of hemlocks, tamaracks and larches. About 200 acres upon the margin of the reservoir have been planted with seedlings grown in the nurseries, and much improvement has been made by the planting along the interior roads about the reservoir and by the cutting out of dead and undesirable trees.

The bodies which had been buried in the old Beaman Cemetery in West Boylston have been removed to a new burial lot adjoining the West Boylston Cemetery. The 65 bodies found were removed, with the respective monuments, headstones and footstones, and properly deposited in the new burial ground. The ground occupied by the burial lot was purchased for the purpose. The lot was graded and seeded and a substantial wall built to enclose it, and a gravel drive leading to it was constructed.

(c) *Location, Construction and Discontinuance of Roads.*

An important feature of the work of the past year has been the building of the embankment across the upper end of the reservoir in West Boylston in continuation of Worcester Street. This embankment has in places a height of 64 feet, and a width of 43 feet at the top and 300 feet at the bottom. Instead of building a masonry bridge with its abutments at the original channel of the river, it was determined to divert the river to the northerly side of the reservoir and to excavate a channel through the rock ledge, and by this means the larger part of the work of building abutments was avoided. A granite bridge has been extended across this channel, having a span of 47.5 feet, the top of the span being at a height of 60 feet above the bed of the channel. The sides of the embankment have been covered with paving. This work has been completed, and the road across the reservoir has been opened to public travel.

The new road from West Boylston has been continued and constructed from Pleasant Street through the village of Oakdale and as far as the new location of Holden Street. A single-arch granite bridge was built at the crossing of the Stillwater River, and a three-arch granite bridge has been constructed where the crossing is made of the Quinepoxet River. Overhead bridges have been built at the two crossings over the Boston & Maine Railroad. Holden Street has also been relocated and substantially reconstructed so as to permit public travel. The new construction of roads at Oakdale has done away with all grade crossings.

There have been no new locations of highways.

During the year a portion of North Main Street extending northeasterly from a point near East Main Street to Pleasant Street has been discontinued, and also the southwesterly part of Pleasant Street between the new highway and North Main Street, all in Oakdale. A small portion also of the old location of the Central Massachusetts Division of the Boston & Maine Railroad in Oakdale has been discontinued.

The following is a list of the roads which have been discontinued during the year on account of the work of construction of the Wachusett Reservoir: —

WACHUSETT RESERVOIR — ARCH BRIDGE OVER THE NEW CHANNEL AT WEST BOYLSTON.

List of Roads discontinued during the Year 1904.

[Including a part of the Central Massachusetts Railroad location, being No. 24.]

No.	Location.	Description.	Date of Discontinuance.
24	West Boylston, Oakdale Village.	That part of the old location of the Central Massachusetts Division of the Boston & Maine Railroad which extends easterly from the new location of said railroad, near the new highway, to that part of the old location heretofore discontinued, near the Worcester, Nashua and Portland Division of the Boston & Maine Railroad.	Feb. 20, 1904.
25	West Boylston, Oakdale Village.	(1) That part of North Main Street which lies between portions of said street heretofore discontinued, extending northeasterly from a point near East Main Street to Pleasant Street. (2) The southwesterly part of Pleasant Street, extending southwesterly between the new highway and North Main Street.	Oct. 15, 1904.

(*d*) *Relocation of the Central Massachusetts Railroad.*

A settlement has been effected with the Boston & Maine Railroad, by which the old track of the Central Massachusetts Railroad through the bed of the Wachusett Reservoir has been surrendered to the Commonwealth; the interchange of lands required for the purposes of the relocation and the adjustment of the account between the railroad and the Commonwealth have been made.

Although the substantial part of the work of relocation was accomplished in the year 1903, some final work has been required during the past year, and some other subsidiary work has been necessary in connection with the relocation of the railroad.

It was deemed necessary to reinforce to a considerable extent the two railroad bridges which cross the Stillwater and Quinepoxet rivers. The masonry generally was grouted; the places opened were filled with mortar, and portions of the wingwalls had to be relaid.

The relocation of the railroad and the operations in connection therewith have required an expenditure of $821,700.77.

(*e*) *Clinton Catholic Cemetery.*

A considerable balance remains due on account of the taking of the lands constituting the St. John's Catholic Cemetery Association in Clinton. In accordance with the tripartite agreement which was executed between the Board, the Roman Catholic Bishop of Springfield and the St. John's Catholic Cemetery Association, incorporated

for the purpose of holding the new cemetery lands which were acquired in Lancaster, the grounds were properly improved and all the bodies were transferred and reburied.

The Board, at the completion of the work, notified the two parties that it stood ready to pay over the balance due in accordance with the agreement, and to convey the lands in Lancaster, to which it has held the title, to the St. John's Catholic Cemetery Association, upon the release to the Commonwealth of the old cemetery lot and of all claims for damages. No action, however, has been taken by either of the two parties toward effecting a final settlement.

(2) Weston Aqueduct and Reservoir.

The Weston Aqueduct and Reservoir were so far completed during the year 1903 that water was first introduced from the terminal chamber into the Metropolitan Water District on one of the last days of that year. During the past year it has been necessary to uncover and clean a portion of the rocky bed of the reservoir, as this work could not be accomplished in the colder weather; to grade and cover with loam a portion of the embankments; and also along the larger part of the aqueduct to grade and seed the embankments, to build the fences and to set the stone bounds. Final work also was done upon the screen-chamber at the reservoir.

Final payments upon contracts have been made, but some claims for allowances under the contracts have not yet been settled, and a few claims for land and other damages also remain to be adjusted.

One siphon pipe required for the crossing of the Sudbury River and Happy Hollow valley in Wayland has been laid, but ultimately three lines of these pipes will be required, as the demands of the District shall increase.

The cost of the aqueduct, extending from the dam at the Sudbury Reservoir to the terminal chamber overlooking the Charles River at Weston, exclusive of the reservoir, will be about $2,500,000, which is about $200,000 per mile of the aqueduct proper. The cost of the reservoir, having an area of 66.6 acres and a capacity exceeding 200,000,000 gallons, is about $350,000, or about $1,720 per million gallons. The cost of both aqueduct and reservoir will, therefore, be about $2,850,000.

The State Board of Health, in its report of 1895, estimated the cost of the aqueduct as then proposed at $3,226,000. This estimate, however, was for one having a capacity of 250,000,000 instead of

WESTON AQUEDUCT—SIPHON CHAMBERS ABOVE HAPPY HOLLOW IN WAYLAND.

300,000,000 gallons per day, and did not include an equalizing reservoir. Although the present aqueduct has a capacity exceeding by one-fifth that formerly proposed and includes in addition the Weston Reservoir, the work as now constructed has been largely within the estimates made by the State Board of Health.

(3) Clinton Sewerage and Filtration Works.

An improvement has been effected during the past year in the filtration works which are used for the purification of the Clinton sewage. In connection with the filter-beds, which are located in the town of Lancaster, 8 separate settling basins have been constructed, each about 320 feet long and 33 feet wide, and having a capacity of about 237,000 gallons.

The basins are in general constructed upon the surface of the ground, so that the bottom may be to a considerable extent impervious to the passage of water. Each basin has an inlet and outlet structure of Portland cement concrete, with gates for controlling the flow of sewage in and out; and they are so arranged that all or a part of the sewage can be passed through them, or that all can be delivered, as formerly, directly to the filter-beds.

By means of these basins the more solid matter of the sewage will settle at the bottom, and, when the basin is emptied, can be speedily disposed of.

(4) Pipe Laying and Venturi Meters.

No construction has been carried on by the Distribution Department during the year except the placing of one Venturi meter. The engineer and his assistants in this department have been called upon to make record plans of work done in past years, and also to spend much time upon the preparation of plans, statistics and estimates in connection with the suit brought by the cities of Malden, Medford and Melrose against the Commonwealth for damages on account of the taking of Spot Pond; and a large increase in the work of maintenance was placed upon the department.

(5) Improvement of Spot Pond Brook.

In response to the special report made in January of the year 1904, the Legislature of that year passed "An Act to provide for the improvement of Spot Pond Brook by the Metropolitan Water and Sewerage Board," which was approved on June 3, 1904, and constituted chapter 406 of the Acts of the year.

This act provided for improving or changing the channel of Spot Pond Brook between Spot Pond in the town of Stoneham and tide-water in the city of Malden, substantially in accordance with the plans and recommendations made in the report of the Board to the General Court in the preceding year. The act, however, provided that no work should be begun upon the improvement until commissioners, who might within three months after the passage of the act be appointed upon the petition either of the Board or of the city of Malden or the city of Melrose, had after hearing made award of the proportion in which the expenses of carrying out the improvement should be paid by the Metropolitan Water District and by the city of Malden and the city of Melrose. The city of Melrose has made petition for the appointment of commissioners as provided in the act, but no hearing has yet been had thereon.

(6) Police Protection.

Police protection has been afforded, in accordance with the requirements of the Metropolitan Water Act, in places where active construction has been carried on. The police officers have been appointed by the various towns in which their services have been required, and they have been subject to the town authorities in the performance of their duties, but they have been paid for their services by the Board.

For the Wachusett Reservoir district there have been employed 18 officers: 8 (reduced to 3 in December) in the town of Clinton; 3, 1 of whom is mounted, (reduced to 1 in December) in the town of Boylston; 6 (reduced to 5 in November and placed on half time in December) in the town of West Boylston; and 1 mounted officer in Sterling.

The construction of the Weston Aqueduct having been entirely completed, the 2 officers in Weston were discharged on February 20, 1904.

(7) Purchases and Takings of Land.

Few lands were acquired by the Board during the past year, as substantially all the lands which are required for the general purposes of construction have now been either purchased or taken.

There were two takings, however, in West Boylston, of land to be used on account of the Wachusett Reservoir, affecting an area of 125.82 acres.

List of Takings for Metropolitan Water Works for the Year 1904.

No.	Location and Description.	Former Owners.	Recorded.	Purpose of Taking.
			1904.	
106	West Boylston and Holden (on Quinepoxet River, both sides of and including a street called River Street in Holden and Holden Street in West Boylston, and a small parcel north of the Boston & Maine Railroad, Central Massachusetts Division). Area, 102.96 acres in fee.	Austin H. Warfield.	March 22.	Wachusett Reservoir.
107	West Boylston (southeast of Pleasant Street and north of land of the County of Worcester Truant School). Area, 22.86 acres in fee.	Heirs of Charles M. Harris *et al.*	April 23.	Wachusett Reservoir.

Settlement has been effected with the owners of all the lands taken or purchased by the Board for the Metropolitan Water Works since the beginning of operations, except for about 127.21 acres, aside from Spot Pond and the contiguous lands and the works of the cities of Malden, Medford and Melrose, payments for which, amounting to $317,820.68, have been made on account. The Spot Pond suits are now pending before a commission. In nearly all cases affecting private lands purchases have preceded the takings.

Settlements under purchases and takings of land, for all purposes of the Water Works, have been effected in the past year in 47 cases, and for an aggregate of 302.005 acres, with the buildings thereon. The sums paid in these settlements have amounted to $144,404.16. In only 9 of these cases have the settlements been results of suits at law, and the total amount paid in the court settlements has been $42,928.90.

Since the beginning of operations upon the Metropolitan Water Works, the number of settlements of this kind effected for the purposes of the Water Works, exclusive of the works of water supply acquired from the city of Boston, on January 1, 1898, has amounted to 818; and under them the Board has acquired rights, in fee or in easements, in 12,011.744 acres, or 18.77 square miles, for which an aggregate of $3,927,852.07 has been paid. Only 41 of these cases have been settled by suits at law, and the total amount paid under judgments of the court has been $136,930.23, or less than 4 per cent. of the whole.

These purchases and takings include lands taken in fee, with the buildings thereon, and water and other rights connected therewith, and lands in which easements and other rights are taken; but they do not include settlements for diversion of water, depreciation and other damages connected with lands not acquired, and in which no fee or easement has been taken.

Summary of Land Settlements for Water Works to December 31, 1904.

LOCATION.	For the Year 1904.			From Beginning of Work.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
*Wachusett Reservoir.**						
Clinton,	6.594	23	$43,645 21	1,286.804	421	$2,825,977 88
Boylston,	26.090			3,926.480		
West Boylston,	9.978			1,637.648		
Sterling,	12.125			714.675		
Lancaster,	-			69.970		
Holden,	-			167.000		
Berlin,	10.120			11.610		
Total,	64.907	23	$43,645 21	7,814.187	421	$2,825,977 88
Improving Wachusett Watershed.						
Holden,	84.300	3	$38,000 00	84.300	3	$38,000 00
West Boylston,	64.430			64.430		
Total,	148.730	3	$38,000 00	148.730	3	$38,000 00
Wachusett Aqueduct.						
Berlin,	-	1	$1,875 00	46.510	65	$74,362 40
Boylston,	-			.380		
Northborough,	-			96.070		
Southborough,	7.270			89.580		
Marlborough,	.660			51.740		
Clinton,	-			13.510		
Total,	7.930	1	$1,875 00	297.790	65	$74,362 40
Sudbury Reservoir.†						
Southborough,	-	-	-	1,995.580	150	$658,318 75
Marlborough,	-			750.980		
Total,	-	-	-	2,746.560	150	$658,318 75

* Including payments on account of St. John's Catholic Cemetery.

† Including settlements made by city of Boston.

Summary of Land Settlements for Water Works to December 31, 1904 — Concluded.

LOCATION.	For the Year 1904.			From Beginning of Work.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
Improving Sudbury Watershed.						
Northborough,	23.470			171.400		
Southborough,	2.166			4.826		
Westborough,	-	2	$3,023 06	202.480	37	$16,522 16
Ashland,	-			.630		
Marlborough,	-			.740		
Total,	25.636	2	$3,023 06	380.076	37	$16,522 16
Clinton Sewerage System.						
Clinton,	-	-	-	5.320	36	$37,794 40
Lancaster,	-			129.860		
Total,	-	-	-	135.180	36	$37,794 40
Weston Aqueduct.						
Newton,	.193			.321		
Weston,	17.240			283.942		
Framingham,	2.740	16	$56,851 69	100.885	76	$166,856 40
Wayland,	34.525			69.379		
Southborough,	-			.450		
Total,	54.698	16	$56,851 69	454.977	76	$166,856 40
Distribution System.						
Boston,	.104			.804		
Brookline,	-			.050		
Arlington,	-			1.800		
Malden,	-			.160		
Medford,	-	2	$1,009 20	2.390	29	$108,420 08
Newton,	-			.060		
Quincy,	-			5.230		
Stoneham,	-			20.850		
Total,	.104	2	$1,009 20	31.344	29	$108,420 08
Improving Lake Cochituate.						
Natick,	-	-	-	2.950	1	$1,600 00
Total,	-	-	-	2.950	1	$1,600 00
Aggregates,	302.005	47	$144,404 16	12,011.744	818	$3,927,852 07

The settlements above enumerated do not take into account the lands acquired under the provisions of the Metropolitan Water Act, which required the Board to take the property held by the city of Boston for the purposes of water supply. The takings from the city under the Act, which were made on January 1, 1898, included the Cochituate works, all the Sudbury works except the then unfinished Sudbury Reservoir, the construction of which had been already assumed by the Board, the Chestnut Hill Reservoir and adjacent lands, and the Mystic works. The lands thus taken aggregated about 3,744 acres, and, in accordance with the agreement made with the city, a sum total of $12,531,000 was paid for the entire works then acquired.

Including the property thus taken from the city of Boston, the settlements have numbered 819; and under them the Board has acquired lands in fee or in easements amounting to about 15,756 acres, or about 24.6 square miles, at a total expenditure of $16,458,-852.07. More than 99 per cent. of the total amount involved in all these settlements has thus been paid in accordance with agreements made without the determination of a court.

Under the similar provision of the Metropolitan Water Act, the Board was required to take, from the cities of Malden, Medford and Melrose, Spot Pond and the adjacent lands, settlement for which has not yet been effected.

(8) Claims and Settlements for Loss of Business.

Additional claims for injury to business, caused by the carrying out of the Metropolitan Water Act in the towns of West Boylston and Boylston and portions of the towns of Sterling and Clinton, have been filed during the year ending December 31, 1904, to the number of 2. Settlements of such claims have been effected during the year in 18 cases, under which the sum of $20,265 has been paid. Two claims have been disallowed. All of these claims except 1 have been settled by the Board outside of the court. The number of claims of this class settled since the beginning of the Water Works has been 282, and the total sum paid on account of such claims has been $139,286.

(9) Claims and Settlements for Loss of Employment.

During the year ending December 31, 1904, 6 claims for loss of employment by residents of West Boylston have been filed. Set-

tlements have been made in 3 cases, the amount paid being $200.49. During the year 6 claims have been disallowed. The whole number of settlements effected has been 474. The total amount paid on account of these claims has been $85,884.65.

(10) Claims and Settlements for Depreciation of Real Estate.

Settlements in 24 cases of injury to real estate in the towns of Clinton, Sterling and West Boylston have been made during the year ending December 31, 1904, and the sum of $26,151.17 has been paid. Of these claims, 2 have been settled in the courts. The total number of claims of this class settled to December 31, 1904, has been 248, and the total amount paid thereon has been $244,395.77.

It was provided by chapter 436 of the Acts of the year 1904 that the owners of real estate situated in that part of the town of Boylston lying on the southerly and southeasterly sides of the reservoir and within the limits of the Nashua River watershed should have the right to recover for damages to real estate not taken, but directly or indirectly decreased in value by reason of the Metropolitan Water Act, in a manner similar to that before provided for owners of real estate in the town of West Boylston. No claims have been allowed by the Board under this act.

(11) Claims on Account of Diversion of Water.

There has been paid during the past year, on account of judgments obtained for the diversion of water, the sum of $37,463.80. The total sum paid under settlements and judgments for such claims since the beginning of the construction of the Water Works has been $1,135,708.91. These claims do not, however, in these or in the preceding cases, include amounts paid for expert services and court expenses.

III. WATER WORKS — MAINTENANCE.

Considerable addition has been made during the past year to the duties of the Engineer of the Distribution Department. On March 10 the Sudbury Department, including also Lake Cochituate and the Cochituate Aqueduct, and on May 25 the Weston Aqueduct, were placed in charge of the Engineer of the Distribution Department. The title of the head of the department was changed to that of En-

gineer of Sudbury and Distribution Departments. This engineer has now, therefore, charge of substantially all the work of maintenance and operation as far west as Southborough. He is assisted by Charles E. Haberstroh, who has the immediate supervision of the Sudbury and Cochituate works and the portion of the Weston Aqueduct above the Weston Reservoir; by George E. Wilde, who has the immediate supervision of the Weston Reservoir and the remainder of the Weston Aqueduct, and of all the reservoirs and pipe lines within the Metropolitan District; and by John W. Lynch who has charge of the several pumping stations.

(1) Operation of Works.

All the 19 cities and towns, included within the Metropolitan Water District, having an estimated population of 972,600, have been supplied with water during the year, except the city of Newton and the town of Hyde Park. These two municipalities, though belonging to the District, have as yet made no application for a supply of water; and, the Board being still of the opinion that they have not reached the safe capacity of their own sources of supply in a dry year, they have been charged with but one-sixth of the entire assessment and have not been supplied with water from the Metropolitan Water Works.

In addition, the town of Swampscott is supplied with water under a special arrangement made with the Board, and a small part of the town of Saugus is permitted to take water under a contract with the Revere Water Company, which supplies water to the town of Revere.

In April a request was made to the Board by the Cambridge Water Board for a temporary supply of water; and, inasmuch as it appeared that an emergency existed in that city, not only by reason of the scarcity of water but also of the danger to health which would arise from the drawing down of Fresh Pond to a lower level, the Board voted to furnish water to the city to meet this emergency, such water to be supplied to the city of Cambridge subject to the same limitations and restrictions as should apply to the cities and towns of the Metropolitan Water District. Under this agreement water was furnished to that city for a period of 39 days, to the amount of 331,540,000 gallons, for which the city paid to the Commonwealth the sum of $15,218.70. Subsequently, in November, a request was again made by the Cambridge Water Board for a temporary supply of water; and, inasmuch as it appeared that a like emergency had

again arisen, the Board agreed to furnish water to the city of Cambridge to the extent of 300,000,000 gallons, subject to the same provisions as before. The 300,000,000 gallons were accordingly furnished, for which the Commonwealth is to receive $15,000.

It was understood that the Cambridge authorities should, upon the meeting of the Legislature, ask for legislation by which the furnishing temporarily of water should be authorized by statute in case a similar emergency should again arise.

Except the water supplied by the city of Newton and the town of Hyde Park from their own sources, the water supplied to the Metropolitan Water District came from the sources of the Metropolitan Water System, and amounted to a total of 41,929,740,000 gallons, or an average daily supply of 114,876,000 gallons.

(2) Storage Reservoirs.

Lake Cochituate, which is the storage reservoir of the Cochituate watershed, has a normal capacity of 2,242,400,000 gallons. In the Sudbury watershed the Sudbury Reservoir has a like capacity of 7,253,500,000 gallons, and the 7 smaller reservoirs have a combined capacity of 6,362,600,000 gallons. All the storage reservoirs, therefore, of the Cochituate and Sudbury watersheds, have a total capacity of 15,858,500,000 gallons. These reservoirs, however, hold at certain periods a somewhat larger amount of water than is estimated as their normal capacity.

These storage reservoirs contained on January 1, 1904, 11,376,800,000 gallons, but were gradually lowered until February 22, when they contained 10,550,000,000 gallons, the lowest amount reached. The largest quantity on storage in these reservoirs was on June 8, when they contained 16,011,500,000 gallons.

The amount of water in storage was largely increased by the additional quantity which was stored in the unfinished Wachusett Reservoir. The amount stored in the Wachusett Reservoir was increased from 1,760,100,000 gallons, at the beginning of the year, to a maximum of 10,117,500,000 gallons on June 8.

There was a maximum total quantity of water in storage for the uses of the Metropolitan Water District on June 8, when the amount of 26,129,000,000 gallons was reached.

The water in the Wachusett Reservoir was carried in June to the full height permitted by the condition of the dam and reservoir. Before this time, considerable water, estimated at 8,600,000,000

gallons, was wasted into the river, because the conditions made it impossible to raise the water to a higher level.

An average of 88,554,000 gallons per day was drawn from the Wachusett Reservoir and conveyed through the Wachusett Aqueduct into the Sudbury Reservoir. From the Framingham Reservoir No. 3, which received not only this supply but also the yield of a considerable portion of the Sudbury watershed, there was drawn and conveyed through the Sudbury Aqueduct an average of 64,827,000 gallons per day, and an average of 30,575,000 gallons per day was carried through the Weston Aqueduct into the District. An average of 9,004,000 gallons per day was also drawn through the Sudbury Aqueduct from Framingham Reservoir No. 2. An average of 14,984,000 gallons per day was drawn from Lake Cochituate through the Cochituate Aqueduct. Lake Cochituate was, however, somewhat reinforced by water received on several days in the year from the Framingham reservoirs. It is estimated that the Spot Pond watershed yielded an average of 497,000 gallons per day, which was in addition to the quantity pumped into the pond.

Water was drawn substantially during the entire year from the Wachusett Reservoir or Nashua River; from the Sudbury Reservoir and Framingham Reservoir No. 3; from Lake Cochituate for a period of 8½ months; from Framingham Reservoir No. 2, Ashland Reservoir and Hopkinton Reservoir for a continuous period of 4 months; and during 15 days from Whitehall Reservoir. No water was drawn from Framingham Reservoir No. 1 or from Farm Pond directly into the District.

A driveway leading to the Sudbury Reservoir and Dam, which had been badly worn during the construction of the Weston Aqueduct, received thorough repairs. A wooden building, arranged for workshop and storage purposes, has been erected in connection with the other buildings of the Commonwealth situated near the Dam. Some repairs were also required at Framingham Reservoir No. 1 and at Lake Cochituate.

(3) Distributing Reservoirs.

The distributing reservoirs, so called, comprising Spot Pond, Chestnut Hill, Fells, Mystic, Waban Hill, Forbes Hill and Bear Hill reservoirs, and the Arlington and Forbes Hill standpipes, which are situated within the Metropolitan District, and were built more especially for the purpose of facilitating the distribution of water

in the District, also serve secondarily for the storage of a large quantity of water which can be drawn upon in case of emergency. The total capacity of the above-named reservoirs is 2,181,230,000 gallons. To this total may be added 200,000,000 gallons, the capacity of the Weston Reservoir, which was built especially as an equalizing reservoir for the waters coming through the Weston Aqueduct. During the past year, also, an arrangement has been made with the Water Commissioners of the city of Chelsea by which water may be drawn from the high-service reservoir in that city in case of emergency, for supplying other cities and towns situated in that portion of the District. In consideration of this use, the Board has made repairs to the lining of the reservoir at a cost of about $4,000. This reservoir has a capacity of 916,500 gallons.

The grounds about Chestnut Hill Reservoir, Spot Pond, Fells Reservoir and Forbes Hill Reservoir, at which the tower commands an extensive view of the surrounding country, have been much resorted to in the summer season for recreation purposes. Mystic Lake, although not now used for water supply purposes, is maintained in good repair, and its waters may be used in case of emergency for the purposes of the District. The estimated capacity of this lake is now 380,000,000 gallons.

(4) Aqueducts.

The Wachusett Aqueduct was kept in use during 283 days of the year. It was emptied for a thorough cleaning, and also for the purpose of repairing some cracks in the aqueduct which had been caused by changes of temperature.

The Sudbury Aqueduct was in operation during 354 days. It was twice emptied for cleaning, and its use was discontinued also for necessary repairs to that portion of the aqueduct which crosses the Waban Bridge. There was a leakage from the aqueduct at this bridge, owing to cracks in the masonry; these were pointed or grouted and washed with cement, and the lower half of the aqueduct for the entire length of the bridge, a distance of 562.25 feet, was lined with sheet lead and otherwise reinforced. Other repairs of a minor character were required at Echo Bridge and at the Beaver Dam Brook culvert.

The Cochituate Aqueduct was in use 259 days during the year.

The flow of the Weston Aqueduct, which had been put into operation at the very end of the preceding year, was shut off for about

three weeks, in order to do the finishing work upon the Weston Reservoir. At the same time some cracks in the aqueduct, which developed soon after construction, were repaired, and other finishing work was accomplished. The aqueduct was in use 320 days.

(5) Pumping Stations.

The operation of the Weston Aqueduct has enabled more than one-fourth part of the entire quantity of water consumed by the District to be supplied by gravity, and has consequently relieved, to a considerable extent, the low-service pumping station at Chestnut Hill.

The average number of gallons pumped per day at the pumping stations during the year was 95,525,000, as appears by the following table: —

NAME.	Total Capacity of Pumps (Gallons per Day).	Average Number of Gallons pumped per Day.
Chestnut Hill, high service,	66,000,000	31,125,000
Chestnut Hill, low service,	105,000,000	55,380,000
Spot Pond,	30,000,000	7,999,000
Arlington,	1,500,000	517,000
West Roxbury,	2,000,000	504,000
	204,500,000	95,525,000

Although the average height to which the water was pumped in the year 1904 was 86.87 feet, or 18.37 feet higher than in the preceding year, the cost per million gallons pumped was $2.615, being a reduction from the preceding year of $0.195. This decrease in cost was largely due both to the reduced price of coal and to the use of a larger proportion of anthracite buckwheat coal and screenings, which it has been found could profitably be mingled with other kinds of coal.

Tests have been made to determine the heating power and value of all the kinds of coal which have been used at the several stations.

The cost per million gallons raised 1 foot was for the Chestnut Hill high-service station $0.024, for the Chestnut Hill low-service station $0.030 and for the Spot Pond station $0.031. The cost is in each case considerably less than that of the preceding year.

(6) Pipe Lines and Pipe Yards.

No new lines of main pipes have been put in service during the year. There have been 19 leaks in pipes, 16 of which were caused by defective joints. Two leaks were discovered in the main pipes, caused by breakage, one in the 30-inch high-service main in the grounds of the Chestnut Hill Reservoir, and the other in the 16-inch high-service main in Winthrop Avenue in Revere. During the year also the 12-inch pipe line on Washington Street in Lynn, for a distance of 553 feet, was relaid on account of the damage done to it by electrolytic action.

The emergency and repair forces, that for the northern district having its headquarters at the Glenwood pipe yard and the other for the southern district at the Chestnut Hill pipe yard, have been able to do all the work of repairing and relaying that has been required.

(7) Clinton Sewerage and Filtration Works.

During the spring months, when the quantity of sewage was large, the pumps of the Clinton Sewerage Works were kept in operation during the night as well as the day. The quantity of sewage pumped and deposited upon the filter-beds has been, upon the average, 43,000 gallons per day less than during the preceding year, the quantity so pumped and deposited daily having been 740,000 gallons. This decrease in the amount of sewage is owing in part to the fact that the Clinton Water Department has continued to increase the number of metered house services, and in part to the fact that, the river being lower, there has probably been less percolation of river water into the defective local sewers.

The 8 new settling basins which have been added to the filtration beds were put into operation near the end of the year. Considerable experimenting has also been made in the methods of caring for the filter-beds, in order to improve further the character of the effluent.

The expense of pumping was somewhat increased, owing to the employment of an additional engineer for the night service. The cost per million gallons pumped was $11.99, as against $9.37 the preceding year. The cost per million gallons filtered was $8.29, as against $7.82 the preceding year.

(8) Sanitary Inspection and Regulations.

Dr. J. J. Goodwin of Clinton has been employed, as heretofore, under the supervision of the engineers in charge of construction, to examine the camps and other buildings occupied by the laborers, for the purpose of keeping such places and the grounds about which construction has been carried on in proper sanitary condition.

The general inspection of the watersheds, which has been exercised by the maintenance department, has been continued during the year under the supervision of William W. Locke, C.E., with two regular assistants. Other assistance has been rendered him by the engineers, and at times day laborers have been employed to carry out the improvements which have been required. There have been no cases of contagious disease arising within the limits of the Wachusett Reservoir, and few such cases upon the watershed. There has been a larger, but not an excessive, number of cases upon the Sudbury and Cochituate watersheds. Efficient measures have been taken in all cases to protect the purity of the water supply.

Inspection has been made of 1,530 premises in the Wachusett watershed, and of 847 premises in the Sudbury and Cochituate watersheds, the conditions of which were for some reason suspected or called for examination. The larger number of these were either found in satisfactory condition, or but slight work was required in order to make them satisfactory. In the more serious cases in the Wachusett watershed remedies have been effected, through the efforts of the inspectors, on 15 premises, and 17 premises have been partially remedied. On the Sudbury and Cochituate watersheds 148 premises have been remedied, all but 4 of them by sewer connections; and, in addition, 25 premises have been partially remedied. The local authorities have in general cooperated with the inspectors for the sanitary improvement of the region, and in no case during the year has it been necessary to resort to the courts in order to enforce the laws and regulations for the prevention of pollution.

A suit which arose in the preceding year, through the claim of the owner of one of the mill properties of the right to discharge polluting matter into the Quinepoxet River, is still pending before the courts.

It has been the policy of the Board, as previously announced, to introduce, at the expense of the Commonwealth, the works which are required for remedying the cases of pollution when the sources

existed prior to the operations of the Board. In cases where the sources of pollution have arisen since the operations of the Board began, it has been made the duty of the owner to pay the cost of such work; but the engineers and inspectors have been willing to offer suggestions regarding the means by which remedies could be supplied.

The ditches which have been dug to drain swamps upon the watershed have been kept in good condition. No ditches were dug during the past year.

Samples of water from as many as 17 different points have been collected at regular intervals of a month or more, and submitted to the State Board of Health for analysis and examination. Samples have also been collected from a larger number of places weekly or fortnightly for examination by the biological force of the Board. Besides, other samples have been taken and examined from time to time, accordingly as called for, from the various reservoirs, brooks and filter-beds. Microscopic organisms have been found more abundant than usual in the Sudbury Reservoir and the Framingham Reservoir No. 3. These have caused some odor in the water, but are entirely innocuous. The organisms in Lake Cochituate have been fewer than usual, so that but for a small portion of the year has the water been found undesirable for use.

(9) Marlborough Brook.

The sewer intended to convey diluted sewage overflowing from the sewers of the city of Marlborough during heavy storms, and an additional filter-bed for purifying the overflow by filtration, which were completed at the end of the preceding year, have been in successful operation. The large filter-bed, which combines with filtration the advantages of a considerable reservoir, has taken care of the overflow from the main sewer during times of freshet. The main filter-beds have, except for portions of six days during freshets, filtered successfully all of the water received from the brook. One of the old storage basins has been much enlarged by increasing its capacity from about 2,600,000 gallons to 9,000,000 gallons. An 18-inch sewer pipe has also been substituted for the open channel, built from the end of the new overflow sewer to the filter-beds.

The analyses which have been received show that the water has generally been satisfactorily purified by the filtration.

IV. WATER WORKS — FINANCIAL STATEMENT.

(1) Metropolitan Water Loan, Receipts and Assessments.

The appropriations for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to these appropriations, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1905, have been as follows: —

Appropriation under chapter 488 of the Acts of 1895, . . .	$27,000,000 00
Appropriation under chapter 453 of the Acts of 1901, . . .	13,000,000 00
	$40,000,000 00
Proceeds from the sales of property applicable to the construction and acquisition of works (of which $20,593.60 is for the year 1904), ...	95,570 85
	$40,095,570 85
Amount approved by the Metropolitan Water and Sewerage Board for payments to December 31, 1904 (of which $2,174,498.19 is for the year 1904), ...	38,388,255 76
Balance January 1, 1905, ...	$1,707,315 09

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $40,000,000, to be designated the "Metropolitan Water Loan," has sold bonds as follows: —

Date.	Bonds sold.	Rate (Per Cent.).	Time (Years).	Price.	Premiums (in Amount).
1895, ...	$2,225,000	3½	40	$110 67	$237,407 50
1896, ...	2,775,000	3½	40	110 67	296,092 50
1896, ...	2,000,000	3½	39	106 76268	135,253 60*
1897, ...	6,000,000	3½	38½	107 82	469,200 00
1898, ...	2,000,000	3½	40	113 176	263,520 00
1898, ...	2,000,000	3½	40	112 877	257,540 00
1899, ...	3,000,000	3	40	100 64	19,200 00
1900, ...	1,000,000	3	39	102 78	27,800 00
1901, ...	3,000,000	3	40	102 155	64,650 00
1901, ...	100,000	3	40	100 375	375 00
1901, ...	150,000	3	40	100 10	150 00
1901, ...	205,000	3	39½	100 25	512 50
1901, ...	50,000	3	39½	100 25	125 00
1901, ...	50,000	3	39½	100 50	250 00

* Including $18,673.60 from readjustment of rate made by the Treasurer in 1897.

Date.	Bonds sold.	Rate (Per Cent.).	Time (Years).	Price.	Premiums (in Amount).
1901, ...	$300,000	3	39½	$100 10	$300 00
1901, ...	200,000	3	39½	100 25	500 00
1901, ...	3,100,000	3½	39½	106 71	208,010 00
1901, ...	1,345,000	3	39½	100 00	-
1901, ...	1,500,000	3	39½	100 00	-
1902, ...	3,000,000	3½	40	109 13	273,900 00
1902, ...	500,000	3½	40	109 13	45,650 00
1903, ...	250,000	3½	40	106 725	16,812 50
1903, ...	1,250,000	3½	40	106 1329	76,661 25
1904, ...	500,000	3½	39½	104 60*	23,000 00
1904, ...	2,000,000	3½	40	104 60	92,000 00
	$38,500,000				$2,508,909 85

* These bonds were temporarily sold in 1903 to the sinking fund at par, and were subsequently, in 1904, resold from the sinking fund at this rate.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

December 31, 1895, ...	$226,286 05
December 31, 1896, ...	699,860 70
December 31, 1897, ...	954,469 00
December 31, 1898, ...	1,416,374 29
December 31, 1899, ...	1,349,332 97
December 31, 1900, ...	1,573,619 72
December 31, 1901, ...	1,662,426 95
December 31, 1902, ...	2,256,803 81
December 31, 1903, ...	2,877,835 59
December 31, 1904, ...	3,519,602 92

The assessments for the year 1904, made by the Treasurer of the Commonwealth, for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works, were as follows: —

Arlington, ...	$12,972 76	Nahant, ...	$3,535 05
Belmont, ...	6,391 85	Newton, ...	10,359 65
Boston, ...	1,700,274 07	Quincy, ...	34,084 24
Chelsea, ...	44,507 49	Revere, ...	15,717 42
Everett, ...	33,537 19	Somerville, ...	86,736 93
Hyde Park, ...	3,091 24	Stoneham, ...	8,343 88
Lexington, ...	6,391 91	Watertown, ...	15,060 77
Malden, ...	46,499 48	Winthrop, ...	9,880 83
Medford, ...	27,519 87		
Melrose, ...	19,722 73		$2,100,800 37
Milton, ...	16,173 01		

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its sources, and had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property, have been, according to the provisions of the Water Act, applied to the payment of interest and sinking fund requirements, and the maintenance and operation of works, as follows: —

For the year 1904,	$12,462 85

The expenditures for the maintenance and operation of the Metropolitan Water Works have been as follows: —

For the year 1904,	$315,780 81

Sums have been received during the year 1904, under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Cambridge,	$15,218 70
Framingham Water Company,	366 80
Revere Water Company,	391 00
Swampscott,	4,100 00
	$20,076 50

At the close of the year, the Treasurer, in accordance with the requirements of the Act, has distributed to the cities and towns of the District, in proportion to the annual assessments theretofore contributed by them, this amount, as follows: —

Arlington,	$113 86	Nahant,	$33 14
Belmont,	59 67	Newton,	97 98
Boston,	16,475 04	Quincy,	319 96
Chelsea,	431 62	Revere,	141 99
Everett,	307 25	Somerville,	820 31
Hyde Park,	29 10	Stoneham,	60 96
Lexington,	18 06	Watertown,	140 82
Malden,	443 63	Winthrop,	87 76
Medford,	260 35		
Melrose,	188 34		$20,076 50
Milton,	46 66		

(2) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction and Acquisition of Works.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Administration applicable to all parts of the construction and acquisition of the works,	. . .	$17,594 74		$239,078 75
Wachusett Dam and Reservoir: —				
Wachusett Dam,	$609,328 07		$1,983,151 99	
North Dike,	63,800 28		747,288 45	
South Dike,	106,034 16		115,541 31	
Removal of soil,	394,487 81		2,838,057 96	
Relocation of railroads,	140,683 75		821,700 77	
Roads and bridges,	83,170 66		464,475 25	
Real estate,	62,173 83		3,141,070 55	
Damages, real estate not taken, business and loss of wages,	46,616 66		469,566 42	
Other expenses,	513 16	1,506,808 88	5,882 22	10,106,234 92
Improving Wachusett watershed,		40,554 03		58,924 81
Wachusett Aqueduct,		1,978 75		1,790,237 62
Sudbury Reservoir,		-		2,922,445 21
Protection of Sudbury supply,		9,045 99		128,797 06
Improving Sudbury watershed,		8,278 84		94,754 58
Protection of Cochituate supply,		-		9,000 00
Improving Cochituate watershed,		-		8,860 68
Improving Lake Cochituate,		-		103,637 29
Pipe lines, Dam No. 3 to Dam No. 1,		-		48,471 48
Pipe line, Rosemary siphon,		-		23,142 98
Weston Aqueduct: —				
Aqueduct,	$91,612 79		$2,316,010 77	
Reservoir,	55,411 77		283,454 79	
Supply pipe lines,	9,464 60		584,033 92	
Real estate, taxes and other expenses,	60,251 58	216,740 74	184,151 24	3,367,650 72
Distribution system: —				
Low service: —				
Pipe lines and connections,	$368 66		$1,751,205 67	
Pumping station, Chestnut Hill,	-		459,251 97	
Reservoir, Spot Pond,	-		578,101 58	
Gate-house and connections, Chestnut Hill Reservoir,	-		65,480 88	
Real estate and other expenses,	2,256 78		86,809 89	
Northern high service: —				
Pipe lines and connections,	249 30		440,539 28	
Spot Pond pumping station,	-		291,829 85	
Fells Reservoir, Stoneham,	-		141,392 94	
Bear Hill Reservoir, Stoneham,	111 90		38,267 70	
Real estate and other expenses,	-		14,838 05	
Amounts carried forward,	$2,986 64	$1,795,996 47	$3,867,717 31	$18,901,136 10

Construction and Acquisition of Works.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Amounts brought forward,	$2,986 64	$1,795,996 47	$3,867,717 31	$18,901,136 10
Distribution system — *Con.*				
Southern high service: —				
Pipe lines and connections,	5 00		504,420 55	
Pumping station, Chestnut Hill,	-		242,121 35	
Forbes Hill Reservoir, Quincy,	-		90,008 49	
Waban Hill Reservoir, Newton,	-		61,502 11	
Real estate and other expenses,	-		10,226 36	
Northern extra high service,	14 00		13,951 47	
Southern extra high service,	52 00		22,815 67	
Meters and connections,	812 74		74,901 28	
Improving Spot Pond Brook,	176 92		3,717 05	
Glenwood pipe yard,	-		33,100 59	
Chestnut Hill pipe yard,	-	4,047 30	11,311 26	4,935,878 49
Diversion of water, South Branch of Nashua River,*		46,723 41		1,357,431 31
Acquisition of existing water works: —				
Reimbursement city of Boston, partially constructed Sudbury Reservoir,	-		$1,157,921 59	
To Boston, for works taken Jan. 1, 1898,	-		12,768,948 80	
To Malden, Medford and Melrose (on account) for taking of Spot Pond,	$317,820 68		343,570 39	
To Newton, for Waban Hill Reservoir,	-		60,000 00	
	$317,820 68		$14,330,440 78	
Transfers of works acquired and other property to accounts for special works,	-		1,240,166 42	
	$317,820 68		$13,090,274 36	
Engineering, conveyancing, etc.,	9,706 94	327,527 62	33,814 54	13,124,088 90
Pipes, Valves, Castings, etc., sent first to Storage Yards, and afterwards transferred as needed to Different Parts of the Work.				
Sent to storage yards,	$921 83		$2,084,380 97	
Transferred from storage yards to works, and included in costs above,	718 44	203 39	2,014,660 01	69,720 96
Total for constructing and acquiring of works,		$2,174,498 19		$38,388,255 76

* Of the total expenditures from the beginning of the work, the sum of $149,102 is for Clinton sewerage system.

Maintenance and Operation.	For the Year ending December 31, 1904.
Administration,	$9,673 13
General supervision,	4,435 85
Taxes and other expenses,	30,314 05
Amount carried forward,	$44,423 03

Maintenance and Operation.	For the Year ending December 31, 1904.	
Amount brought forward,	. . .	$44,423 03
Wachusett Reservoir Department: —		
Sanitary inspection,	$2,369 79	
Buildings,	474 72	
Reservoir,	3,491 36	
		6,335 87
Wachusett Dam and Aqueduct Department: —		
General superintendence,	$1,881 49	
Dam and aqueduct,	10,473 71	
Clinton sewerage system: —		
Pumping station,	3,135 75	
Sewers, screens and filter-beds,	4,444 19	
Sanitary inspection,	67 70	
		19,502 84
Sudbury Department: —		
General superintendence,	$3,931 82	
Superintendence, Framingham office,	6,872 77	
Ashland Reservoir,	1,406 17	
Hopkinton Reservoir,	1,883 08	
Whitehall Reservoir,	252 75	
Framingham Reservoirs, 1, 2 and 3,	4,890 26	
Sudbury Reservoir,	6,308 62	
Lake Cochituate,	3,156 46	
Marlborough Brook filters,	6,547 66	
Pegan filters,	3,088 16	
Sudbury and Cochituate watersheds,	787 86	
Sanitary inspection,	2,568 83	
Sudbury and Cochituate Aqueducts,	22,651 37	
Weston Aqueduct,	7,647 30	
Biological laboratory,	2,568 84	
		74,061 95
Distribution Department: —		
Superintendence,	$12,549 03	
Arlington pumping station, pumping service,	5,354 80	
Chestnut Hill low-service pumping station, pumping service,	31,146 31	
Chestnut Hill high-service pumping station, pumping service,	32,283 07	
Spot Pond pumping station, pumping service,	11,950 08	
West Roxbury pumping station, pumping service,	6,087 31	
Arlington standpipe,	40 88	
Bear Hill Reservoir,	135 52	
Chelsea Reservoir,	4,036 01	
Chestnut Hill Reservoir,	8,813 42	
Fells Reservoir,	735 70	
Forbes Hill Reservoir,	1,247 61	
Mystic Lake, conduit and pumping station,	3,277 75	
Mystic Reservoir,	1,752 91	
Waban Hill Reservoir,	500 14	
Spot Pond,	8,990 67	
Buildings at Spot Pond,	38 39	
Amounts carried forward,	$128,939 60	$144,323 69

Maintenance and Operation.	For the Year ending December 31, 1904.	
Amounts brought forward,	$128,939 60	$144,323 69
Distribution Department — *Con.*		
Pipe lines: —		
Low service,	13,000 16	
Northern high service,	8,952 01	
Southern high service,	3,115 61	
Supply pipe lines,	812 20	
Buildings at Chestnut Hill,	1,632 30	
Chestnut Hill pipe yard,	1,481 05	
Glenwood pipe yard and buildings,	4,733 94	
Stables,	5,915 58	
Waste prevention,	4,434 65	
Venturi meters,	3,440 02	
		171,457 12
Total for maintaining and operating works,		$315,780 81

(3) Detailed Financial Statement.

The Board herewith presents, in accordance with the Metropolitan Water Act, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year 1904.

(*a*) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1904, and ending December 31, 1904, is $2,174,498.19; and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1904, is $38,388,255.76.

For maintenance and operation the expenditures for the year have been $315,780.81, and from the beginning of the work, $1,912,536.44.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

General Character of Expenditures.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Construction of Works and Acquisition by Purchase or Taking.				
Administration.				
Commissioners,	$5,833 33		$100,976 92	
Secretary and auditor,	2,894 28		44,115 11	
Clerks and stenographers,	4,933 88		49,224 15	
Legal services,	-		2,359 00	
Travelling,	488 91		3,409 09	
Stationery and printing,	1,287 71		8,671 98	
Postage, express and telegrams,	223 75		2,563 37	
Furniture and fixtures,	44 15		4,133 44	
Alterations and repairs of buildings,	2 41		5,743 27	
Telephone, lighting, heating, water and care of building,	1,026 10		9,737 94	
Rent and taxes, main office,	603 00		3,855 80	
Miscellaneous expenses,	257 27	$17,594 74	4,288 68	$239,078 75
Engineering.				
Chief engineer and department engineers,	$16,859 42		$193,107 99	
Principal assistant engineers,	11,568 41		136,790 84	
Engineering assistants,	68,445 47		946,273 78	
Consulting engineers,	-		23,437 07	
Inspectors,	22,317 07		281,855 34	
Architects,	3,116 45		32,528 39	
Railroad and street car travel,	777 10		26,606 15	
Wagon hire,	4,308 64		42,772 96	
Stationery and printing,	905 18		24,797 08	
Postage, express and telegrams,	563 10		7,452 85	
Engineering and drafting instruments and tools,	49 22		19,225 73	
Engineering and drafting supplies,	898 17		23,916 48	
Books, maps and photographic supplies,	356 31		6,369 44	
Furniture and fixtures,	46 73		14,876 97	
Alterations and repairs of buildings: —				
Main office,	472 32		13,938 36	
Sub-offices,	111 50		2,860 07	
Telephone, lighting, heating, water and care of buildings: —				
Main office,	2,773 56		19,858 68	
Sub-offices,	2,079 38		17,447 02	
Rent and taxes, — main office,	1,809 00		11,335 75	
Rent of sub-offices and other buildings,	252 00		4,518 74	
Field offices and sheds,	13 30		1,274 49	
Clinton office building,	-		9,866 87	
Unclassified supplies,	589 31		8,175 53	
Miscellaneous expenses,	520 20	138,831 84	8,452 21	1,877,233 79
Amounts carried forward,		$156,426 58		$2,116,312 54

General Character of Expenditures.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Amounts brought forward, . . .	. . .	$156,426 58		$2,116,312 54
Construction.				
Preliminary work (borings, test pits and other investigations): —				
Advertising, ...	$82 60		$6,188 55	
Other preliminary work as given in detail in preceding annual report, ...	-		155,456 66	
		82 60		161,645 21
Contracts, Wachusett Reservoir: —				
Contracts completed and final payments made prior to January 1, 1904, . . .	-		$2,062,386 09	
Busch Bros., excavating soil, Sect. 6, and building road, West Boylston and Boylston, — $600 due, deducted from estimate, September 5, 1900, ...	-		34,560 63	
Newell & Snowling Construction Co., excavating soil from Sect. 8, and completing westerly portion of North Dike, . .	$125,728 22		394,592 50	
Bruno, Salomone & Petitti, Sect. 10, Wachusett Reservoir, Boylston and West Boylston, ...	257,999 39		424,768 56	
McArthur Bros. Co , building Sect. 2 of the Relocation of Central Massachusetts Railroad, ...	-		246,439 34	
The George M. Atkins Co., arch bridges and abutments at Oakdale, ...	5,735 63		38,528 22	
Francis A. McCauliff, masonry arch bridge at West Boylston, ...	11,233 09		11,233 09	
John F. Magee & Co., South Dike, . .	118,034 45		118,034 45	
McArthur Bros. Co., placing riprap on the westerly portion of the North Dike, . .	34,282 06		51,017 50	
McArthur Bros. Co., Wachusett Dam, .	496,528 24		1,423,940 48	
Wm. Cramp & Sons Ship and Engine Building Co., bronze grooves for Wachusett Dam, ...	3,691 00		3,691 00	
Davis & Farnum Manufacturing Co., castings for Wachusett Dam, ...	1,248 97		1,248 97	
Gibby Foundry Co., castings for Wachusett Dam, ...	1,205 53		1,205 53	
Coffin Valve Co., sluice gates for Wachusett Dam, ...	1,687 00		7,887 00	
Chapman Valve Manufacturing Co., valves for Wachusett Dam, ...	2,317 67		2,317 67	
Connery & Wentworth, superstructure of lower gate-chamber of the Wachusett Dam, ...	55,971 20		55,971 20	
		1,115,657 45		4,877,822 28
Contracts completed, Wachusett Aqueduct, .	-			1,447,208 55
Contracts completed, Sudbury Reservoir, .	-			1,545,028 33
Amounts carried forward, ...	-	$1,272,166 63		$10,148,016 86

General Character of Expenditures.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Amounts brought forward,	-	$1,272,166 63		$10,148,016 86
Construction — Con.				
Contracts, protection Sudbury Supply: —				
City of Marlborough, main sewer,	-	9,000 00		9,000 00
Contracts completed, improving Lake Cochituate,	-			60,657 45
Contracts completed, protection Cochituate Supply: —				
Town of Framingham, low-level sewer,	-			9,000 00
Contracts completed, Rosemary siphon,	-			5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1,	-			17,240 22
Contracts completed, Clinton sewerage system,	-			66,878 22
Contracts, Weston Aqueduct: —				
Contracts completed and final payments made prior to January 1, 1904,	-		$366,458 02	
T. H. Gill, Sect. 1,	$28 12		34,483 39	
Shanahan, Casparis & Co, Sect. 2,	-		197,645 17	
Sundry bills paid under this contract,	2,397 62		2,911 80	
Shanahan, Casparis & Co., Sect. 3,	-		122,280 42	
Sundry bills paid under this contract,	3,797 44		4,214 78	
Bruno, Salomone & Petitti, Sect. 5,	125 28		128,226 63	
Shanahan, Casparis & Co., Sect. 6,	-		106,805 66	
Sundry bills paid under this contract,	6,968 05		6,968 05	
Winston & Co., Sects. 8 and 10,	2,000 00		146,552 09	
Winston & Co., Sect. 11,	5,258 89		159,892 59	
Shanahan, Casparis & Co., Sect. 12,	-		135,181 78	
Sundry bills paid under this contract,	3,339 77		3,339 77	
Michael H. Keefe, Sect. 13,	-		11,206 05	
Columbus Construction Co., Sect. 13,	12,472 79		406,046 59	
Nawn & Brock, Sect. 14,	3,818 44		59,449 04	
Winston & Co., Sect. 15,	7,000 00		168,642 96	
Nawn & Brock, Weston Reservoir, Sect. 1,	6,434 33		63,778 33	
Nawn & Brock, Weston Reservoir, Sect. 2,	31,454 68		128,970 70	
Dennis F. O'Connell, supply pipe lines, Sect. 2,	1,500 00		71,287 87	
C. A. Dodge & Co, superstructures of the head and meter chambers,	4,740 00		10,804 00	
Woodbury & Leighton, superstructures of the channel and screen chambers,	4,780 75	96,115 61	12,484 75	2,342,630 44
Contracts completed, Distribution System,	-		$4,383,372 31	
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900,	-		3,139 77	4,380,232 54
Amounts carried forward,	-	$1,377,282 24		$17,039,572 69

General Character of Expenditures.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Amounts brought forward,	-	$1,377,282 24		$17,089,572 69
Construction — Con.				
Additional work: —				
Labor,	$60,356 83		$634,404 08	
Professional services, medical services, analyses, etc.,	81 00		1,608 99	
Travelling,	597 75		1,989 97	
Rent,	-		3,556 73	
Water rates,	45 91		1,421 08	
Freight and express,	1,496 32		11,838 71	
Jobbing and repairing,	435 73		8,452 94	
Tools, machinery, appliances and hardware supplies,	4,260 38		71,382 94	
Electrical supplies,	44 22		4,830 21	
Castings, ironwork and metals,	4,530 89		61,115 30	
Iron pipe and valves,	2,510 92		54,315 05	
Blasting supplies,	122 34		1,339 48	
Paint and coating,	174 70		4,065 60	
Fuel, oil and waste,	292 24		10,339 37	
Lumber and field buildings,	3,669 30		79,954 58	
Drain pipe,	1,274 56		8,699 48	
Brick, cement and stone,	5,439 34		23,724 36	
Sand, gravel and filling,	85 00		5,837 26	
Municipal and corporation work,	102,802 04		207,656 39	
Police service,	15,435 50		202,838 83	
Sanitary inspection,	1,205 00		11,822 18	
Judgments and settlements for damages,	2,040 67		37,294 61	
Unclassified supplies,	2,666 07		14,402 66	
Miscellaneous expenses,	187 15		3,038 28	
		209,704 31		1,465,429 08
Legal and expert: —				
Legal services,	-		$4,668 82	
Expert services,	-		522 74	
Court expenses,	$100 00		909 04	
Miscellaneous expenses,	-		49 05	
		100 00		6,149 65
Real Estate.				
Legal and expert: —				
Legal services,	-		$4,736 31	
Conveyancer and assistants,	$5,567 50		99,388 97	
Experts,	300 00		17,871 58	
Appraisers,	1,927 00		21,049 09	
Court expenses,	3,416 00		8,428 30	
Counsel expenses,	-		43 25	
Conveyancing supplies,	43 91		3,149 53	
Conveyancing expenses,	285 72		5,717 98	
Miscellaneous expenses,	336 80		3,928 12	
Settlements made by Board,	101,475 26		3,259,315 84	
Amounts carried forward,	$113,352 19	$1,587,086 55	$3,423,629 47	$18,511,151 42

General Character of Expenditures.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Amounts brought forward,	$113,352 19	$1,587,086 55	$3,423,629 47	$18,511,151 42
Real Estate — Con.				
Judgments,	42,928 90		136,930 23	
Taxes and tax equivalents,	-		67,917 07	
Care and disposal,	6,883 41	163,164 50	67,412 97	3,695,889 74
Damages to Real Estate not taken, to Business and on Account of Loss of Wages.				
Legal and expert: —				
Legal services,	-		$1,130 67	
Expert services,	$787 16		1,635 08	
Court expenses,	1,159 60		10,239 59	
Settlements,	38,851 66		380,867 82	
Judgments,	7,765 00	48,563 42	88,698 60	482,571 76
Claims on Account of Diversion of Water.				
Legal and expert: —				
Legal services,	-		$3,774 98	
Expert services,	$396 31		19,339 60	
Court expenses,	1,435 25		19,105 60	
Miscellaneous expenses,	-		1,222 63	
Settlements,	-		917,850 00	
Judgments,	37,463 80	39,295 36	218,358 91	1,179,151 90
Purchase of Existing Water Works.				
Legal and expert: —				
Legal services,	-		$1,878 89	
Expert services,	$1,718 96		4,369 61	
Court expenses,	3,733 38		3,733 38	
Miscellaneous expenses,	518 00		1,470 94	
Settlements and judgments,	317,820 68	323,790 97	14,330,440 78	14,341,893 55
Relocation Central Massachusetts Railroad.				
Settlements,		12,597 30		177,597 30
Total amount of construction expenditures,		$2,174,498 19		$38,388,255 76

General Character of Expenditures.	For the Year ending December 31, 1904.
Maintenance and Operation of Works.	
Administration: —	
Commissioners,	$3,500 00
Secretary, auditor and assistants,	3,767 67
Postage, printing, stationery and other supplies,	1,496 92
Travelling,	120 31
Telephone, heating, lighting and care of building,	322 90
Alterations and repairs of building,	151 68
Rent and taxes, office building,	150 00
Miscellaneous expenses,	163 65
Amount carried forward,	$9,673 13

General Character of Expenditures.	For the Year ending December 31, 1904.	
Amount brought forward,	$9,673 18	
Maintenance and Operation of Works — *Con.*		
Supervision and general superintendence: —		
Chief engineer and department engineers,	9,333 92	
Engineering and clerical assistants,	8,001 58	
Postage, printing, stationery and office supplies,	829 54	
Telephone, heating, lighting and care of offices,	1,080 16	
Travelling and incidental expenses,	1,846 64	
Alterations and repairs of buildings,	346 41	
Rent and taxes, main office,	450 00	
Miscellaneous expenses,	459 94	
Pumping service: —		
Labor,	46,150 29	
Fuel,	35,347 61	
Oil, waste and packing,	1,234 08	
Repairs and renewals,	843 90	
Small supplies and expenses,	2,469 17	
Rent, West Roxbury pumping station,	776 52	
Superintendents and assistant superintendents,	8,363 99	
Engineering assistants,	13,213 21	
Laboratory force,	1,884 02	
Sanitary inspectors,	2,779 92	
Recording and scientific instruments and supplies,	691 76	
Labor and teaming,	107,066 81	
Tools, machinery and appliances,	2,719 15	
Lumber and hardware supplies,	3,248 79	
Jobbing and repairing,	1,092 71	
Travelling,	5,224 41	
Horses, vehicles and stable expenses,	5,201 08	
Fuel, lighting and telephone,	3,973 62	
Municipal and corporation work,	35 50	
Unclassified supplies,	11,180 65	
Miscellaneous expenses,	2,313 98	
Conveyancer and assistants,	560 00	
Taxes and tax equivalents,	29,754 05	
Contracts and agreements,	955 00	
Contracts for pipes, valves, etc., bought from construction work since January 1, 1904,	1,729 27	
Total expenditures for maintenance and operation,		$315,780 81

(*b*) *Receipts.*

The total amount of receipts from rents, sales of property, etc., for the year beginning January 1, 1904, and ending December 31, 1904, is $53,132.95, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1904, is $392,652.84. The general character of these receipts is as follows: —

General Character of Receipts.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
For distribution back to District: —				
District entrance fees,	-		$92,265 00	
Supplying water outside of District,	$19,318 70		51,656 84	
Water furnished to water companies,	757 80	$20,076 50	36,704 03	$180,625 87
To the credit of the loan fund: —				
Real estate and buildings,	$4,822 22		$19,586 48	
Labor, tools, supplies and reimbursements,	15,771 38	20,593 60	75,984 37	95,570 85
To the credit of the sinking fund: —				
Forfeiture for contracts awarded but not executed,	-		$500 00	
Rents,	$5,846 18		81,943 15	
Land products,	4,696 48		31,696 37	
Unclassified receipts and interest,	1,920 19	12,462 85	2,316 60	116,456 12
Total receipts,	. . . .	$53,132 95		$392,652 84

The foregoing receipts have been credited to the various objects or works, as follows: —

Receipts from Different Works.	For the Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
Distribution back to District: —				
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton and Lexington),	-		$92,265 00	
Supplying water to cities and towns outside of Water District (Swampscott, Lexington and Cambridge),	$19,318 70		51,656 84	
Water furnished to water companies,	757 80	$20,076 50	36,704 03	$180,625 87
Construction and acquisition of works: —				
Administration,	$12 40		$13 15	
Wachusett Dam,	-		4,897 09	
Wachusett Reservoir,	7,426 07		104,138 25	
Wachusett Aqueduct,	-		5,204 70	
Weston Aqueduct,	2,131 82		4,313 74	
Sudbury Reservoir and watershed,	19 60		7,274 76	
Distribution system,	11,569 48		54,701 74	
Diversion of water, Clinton sewerage system,	534 18		1,191 09	
Purchase of existing water works,	1,365 53	23,059 08	8,591 02	190,325 54
Maintenance and operation of works: —				
Wachusett Aqueduct,	$517 67		$3,060 61	
Wachusett Reservoir,	5,310 67		5,310 67	
Sudbury system,	1,258 84		6,856 93	
Distribution system,	2,333 01		4,279 78	
Clinton sewerage system,	577 18	9,997 37	2,193 44	21,701 43
Total receipts,	. . . .	$53,132 95		$392,652 84

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(d) *Liabilities.*

There are liabilities as follows: —

Current bills unpaid,	$11,796 81*
Due on monthly pay rolls,	3,586 51
	$15,383 32

Amounts reserved on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
McArthur Bros. Co.,	Wachusett Dam,	$30,000 00
Busch Bros.,	Building road, Wachusett Reservoir,	600 00
Bruno, Salomone & Petitti,	Wachusett Reservoir, Sect. 10,	25,000 00
John F. Magee & Co.,	South Dike,	20,529 61
Connery & Wentworth,	Superstructure of the lower gate-chamber, Wachusett Dam,	13,992 80
F. A. McCauliff,	Masonry arch bridge at West Boylston,	1,982 31
McArthur Bros. Co.,	Relocation Central Massachusetts Railroad, Sect. 2,	10,000 00
Winston & Co.,	Weston Aqueduct, Sects. 8 and 10,	147 43
		$102,252 15

Amounts have been agreed upon in the following cases, but the deeds have not yet passed: —

Winthrop Parker *et al.*, trustees, $425; Martha E. Prescott, estate of, $400; Edmund F. Brigham *et als.*, $400; Bertram A. Bancroft, $115; Lucy White, $250; Pratt & Inman, $48; Charles F. C. Henderson, $800; Kayajan Serabian, $130; Anna M. Bennett, $160; P. Arvid Lundgren, $745; Walter E. Reeves, $845.

On the claims of the following it is impossible to state the amounts due for land damages and water rights, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

* Miscellaneous current bills of 1904, including those coming in from time to time, after January 1, 1905, have since been paid.

Charles L. Johnson, Charles B. Sawin, city of Malden, balance, city of Medford, balance, city of Melrose, balance, Emory A. Bacon, James Dorr, Framingham Water Company, Charles W. Felt, town of West Boylston, Eliza M. Childs *et al.*, Charles J. Paine, George H. Thompson, Benjamin W. Clemmons, town of Framingham, Henry S. Milton *et al.*, trustees, Marion Preston, George A. Ward *et al.*, Edward Dooley, Harry Dutton *et al.*, Charles A. Warren, Ida M. Tay, William Dwyer.

V. SEWERAGE WORKS — CONSTRUCTION.

The Metropolitan Sewerage Works provide for the sewage of areas amounting to 193 square miles, including the whole or parts of 25 cities and towns in the Metropolitan District. The works are embraced in two systems: the North Metropolitan System, which provides for the district situated largely in the Charles River and Mystic River valleys, lying north of the Charles River, and whose sewage is carried to Deer Island and thence emptied into Boston harbor; and the South Metropolitan System, which provides for the sewage of the portion of the Charles River valley lying south of the Charles River, as well as the city of Waltham and the town of Watertown, situated on the north side of the river, and also for a portion of the Neponset River valley and the city of Quincy, and having its outlet, by the recently completed High-level Sewer, also into Boston harbor.

Within these areas have been laid 95.55 miles of main sewers, 87 miles of which were constructed by the Metropolitan boards, and 8.79 miles were purchased from the cities and towns. These areas remain the same as last year, and are more particularly described in the report of the Engineer of the Sewerage Works, which follows.

The amount expended during the past year on account of the Sewerage Works was $829,941.92, of which $184,655.82 was expended on the North Metropolitan System and $645,286.10 on the South Metropolitan System.

The total cost of the Metropolitan sewers, including 6 pumping stations and other structures used in connection therewith, has been $13,666,832.38; and of this total there is charged to the North Metropolitan System $6,086,569.91, and to the South Metropolitan System $7,580,262.47.

(1) North Metropolitan System.

The extension of the North Metropolitan Sewer through the city of Chelsea to the town of Revere, and the extension of the Cambridge branch of the sewer to the town of Belmont, both begun in the year 1903, have been constructed, and all sewers so far authorized upon this system have been completed.

Owing to peculiar difficulties in the construction of the Revere extension, resulting from the presence of quicksand, the peculiar clay and silt formation in the tunnels, and the necessity of crossing Mill Creek, it was deemed expedient to proceed with the construction of the sewer by day labor. This sewer has a total length of 7,312 feet, with substantial diameters of 54 and 48 inches except at the Mill Creek crossing, where 36-inch cast-iron pipes have been laid. The total cost of the sewer was $214,451.71. This extension was completed and opened for service on October 8.

The sewer built through portions of the city of Cambridge to the town of Belmont was completed under contract, on July 20. It has a length of 6,358 feet, and, though built in sections somewhat different from each other, has a substantial diameter of 25 inches. The expenditures for this sewer to date have amounted to $56,550.69. There are remaining unpaid some small claims for land damages.

(2) South Metropolitan System.

The work of construction on the South Metropolitan System has consisted principally of the completion of the High-level Sewer. The sewer proper had been chiefly built before the beginning of the year, and considerable progress had been made in the erection of the necessary structures. During the year the larger portion of one of the two outfall pipes in the harbor, which remained to be placed, has been laid; the superstructure of the screen-chamber and sand-catcher on Nut Island has been erected; the Ward Street pumping station has been finished, and the pumps, engines and boilers have been installed; the necessary connections between the High-level Sewer and the Charles River valley and the Neponset valley sewers have been made; and the various unfinished portions of the sewer have been completed.

The Ward Street pumping station was put in operation and the High-level Sewer was opened for service on October 14, since which

WARD STREET PUMPING STATION.

date the sewage from the portion of the Charles River valley above Vancouver Street has been pumped and discharged through the sewer from the outfall into the harbor.

Connection was made with the Neponset River valley sewer, at the junction of the sewers in Hyde Park, on November 22, and since that date the sewage from the Neponset River valley system above that point has also been discharged through the High-level Sewer.

But little more remains to be done for the entire completion of the High-level Sewer. The chief work required is the laying of a force main in Quincy, for the purpose of connecting the Quincy pumping station with the sewer; and this work will be begun as early as practicable in the coming season and will probably be performed by the employés in the maintenance department. Until this is finished the sewage from that station will continue to be disposed of through the Moon Island outfall of the city of Boston.

The final grading of the grounds about the Ward Street station and also about the screen-chamber at Nut Island has necessarily been deferred until the coming season.

A small portion of the territory in the Back Bay district of Boston, situated below Vancouver Street, is still unconnected with the High-level Sewer; and the making of this connection is awaiting arrangements which may be effected with the city of Boston for the mutual advantage of that city and of the Commonwealth, which will probably be determined early in the coming year. It is not proposed at present to discharge the sewage of small portions of Dorchester and Milton, included in the Neponset valley system with the High-level Sewer, as the areas are too low for sewage to be delivered into the High-level Sewer without pumping. Satisfactory arrangements for the disposal of the sewage of these small sections, which are not provided for by the High-level Sewer, have been made with the city of Boston.

The expenditures for the High-level Sewer up to the present date have been $5,876,751.94. The appropriations for the sewer amounted to $5,981,000. The work to be done, which is comparatively small in amount, will undoubtedly be accomplished within the appropriations.

The High-level Sewer, which has now been substantially completed, extends from near Ward Street in the city of Boston through

portions of that city and through the towns of Hyde Park and Milton and the city of Quincy to Nut Island, a distance of 16.83 miles. Of the total length, 12.75 miles are constructed in open trench and 4.08 miles in tunnel. From Nut Island the sewage is conveyed through two submarine 60-inch cast-iron pipes to points in the harbor, each a little more than one mile beyond the low-water mark, where outfalls have been built. The sewer has a capacity for the daily discharge of 300,000,000 gallons of sewage.

Nut Island has been graded, and the soil removed was used principally in the construction of the embankment upon the bar connecting Nut Island with Hough's Neck in Quincy. A building, principally of brick, about 78 feet long, 60 feet wide and 40 feet in height, with a chimney 100 feet high, has been built upon the island. This building embraces a screen-chamber, where practically all the objectionable solid matters in the sewage will be intercepted, and a boiler room with boilers, which will provide the necessary steam for heating the building and operating the small engines for moving the screens. Approaching the building the sewer section has been considerably enlarged, so as to deposit sand which follows along the sewer. The solid matters intercepted at the screens will be burned in the boilers, and the arrangements are such that the sand may be removed from the sand-catcher before entering the outfall pipes.

The Ward Street pumping station includes an engine house about 65 by 120 feet, and a boiler room and accessories about 38 by 105 feet. The height of the engine house is about 55 feet. It is constructed of brick, with granite trimmings. Two pumping engines have been installed, each having a daily capacity for pumping 50,000,000 gallons. The station is also equipped with the necessary boilers, screens and other machinery.

(3) Purchases and Takings of Land.

Only one taking, required for the purpose of the Quincy force main, has been made for the Metropolitan Sewerage Works during the year, being of easements in 1.68 acres, of which .89 acre was in a street.

HIGH LEVEL SEWER – NUT ISLAND AND SCREEN CHAMBER AT END OF 1904.

List of Takings for Metropolitan Sewerage Works for the Year 1904.

No.	Location and Description.	Former Owners.	Recorded.	Purpose of Taking.
11	Quincy (from Greenleaf Street northerly through Park Lane to the easterly line of the Metropolitan Park Reservation, then from the westerly line of the Reservation through Merrymount Park, to the Quincy pumping station). Area, easements in 1.68 acres.	City of Quincy *et al.*	1904. Jan. 27.	High-level Sewer (Quincy force main).

Since January 1, 1904, settlements have been effected on account of the takings made in the North Metropolitan District in three cases, involving a payment of $1,550; and in cases in the South Metropolitan District two settlements have been effected, under which payments have been made amounting to $4,398.22.

Summary of Land Settlements for the Year 1904

Location.	Area in Acres.	Number of Settlements.	Payments.
North Metropolitan District.			
Cambridge,	0.256	3	$1,550 00
Total,	0.256	3	$1,550 00
South Metropolitan District.			
Quincy,	0.865	2	$4,398 22
Total,	0.865	2	$4,398 22
Aggregate,	1.121	5	5,948 22

VI. SEWERAGE WORKS—MAINTENANCE.

(1) North Metropolitan System.

The maintenance of the North Metropolitan System involves the care of 58.004 miles of Metropolitan main sewers, into which is received the sewage of the different municipalities of the District through 558.18 miles of local sewers, having 58,987 connections. There are maintained for this system four pumping stations,—the Alewife Brook pumping station at Somerville, the Charlestown pumping station, the East Boston pumping station and the Deer Island pumping station. The total number of gallons of sewage pumped during the year has been 53,739,119,000. The population

of the various municipalities and parts of municipalities embraced in the North Metropolitan District is estimated at 494,500, of which it is estimated that a population of 387,327 is directly contributing sewage. The sewers in 12 of the municipalities are separate sewers, in 5 municipalities separate and combined sewers, and in one municipality combined sewers only.

The average cost of pumping per million gallons raised 1 foot, including labor at the screens, was $0.349 at the Alewife Brook station, $0.159 at the Charlestown station, $0.065 at the East Boston station and $0.094 at the Deer Island station.

During the past year the wharf at Deer Island has been largely renewed, the water pipes at the station have been extended so as to provide additional fire protection for the dwelling houses and lockers, and considerable riprap has been deposited on the Deer Island bar over the line of the outfall sewer. Considerable repairs have been required at the ends of the Malden River siphon and in the embankment across the marsh. Necessary changes have been made by which the old Mystic valley sewer in Winchester has been relieved.

The expenditures for maintenance of the North Metropolitan System for the year have amounted to $112,047.98.

(2) South Metropolitan System.

The Metropolitan sewers in the South Metropolitan System have a total length of 37.548 miles, and these receive the sewage of the District through 406.32 miles of local sewers, having 20,117 connections.

The Ward Street pumping station, the Quincy pumping station and the screen-house and sand-catcher at Nut Island are also maintained for this system. The number of gallons of sewage pumped during the year at the Quincy pumping station has been 1,338,810,000, and at the Ward Street pumping station, from October 14 to the end of the year, 1,002,900,000. The population of the various municipalities and parts of municipalities embraced in the South Metropolitan District is estimated at 318,300, and of this population it is estimated that 147,761 are now directly contributing sewage. Of the municipalities in the District, 7 have separate sewers and 5 separate and combined sewers.

The average cost of pumping per million gallons raised 1 foot, including labor at the screens, was $0.151 at the Quincy station. Owing to the short time during which the Ward Street station has

been in operation, the statistics regarding the cost of pumping at this station are not available.

Considerable work will be required from the maintenance department on account of the recent completion of the High-level Sewer, the Ward Street pumping station and the screen-house at Nut Island, in equipping these works for regular operation.

The sum of $139,640.88 has been expended during the year for the maintenance of the South Metropolitan System.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

(1) Construction Loans and Receipts.

The appropriations for the construction of the Metropolitan Sewerage Works, the receipts which are added to the appropriations, and the expenditures for construction, have been as follows: —

(a) *North Metropolitan System.*

Appropriations under various acts of the Legislature (given in detail in report for the year 1901),	$5,605,865 73
Appropriations under chapters 242, 336 and 399, Acts of 1903,	500,000 00
Proceeds from sales of property and from other sources to December 31, 1904,	17,023 53
	$6,122,889 26
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1904 (of which $184,655.82 is for the year 1904),	6,086,569 91
Balance, North Metropolitan System, January 1, 1905,	$36,319 35

(b) *South Metropolitan System.*

Charles River Valley Sewer.

Appropriations under the Acts of the years 1889 and 1900,	-	$800,046 27
Amount approved by the Metropolitan Sewerage Commission for payment to December 31, 1904,	$800,046 27	

Neponset River Valley Sewer.

Appropriations under various acts of the Legislature (given in detail in report for the year 1901),	-	900,000 00
Appropriation, chapter 315, Acts of 1903,	-	4,000 00
Proceeds from pumping ground water,	-	109 50
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1904 (of which $150 is for the year 1904),	903,464 26	

High-level Sewer.

Appropriation under chapter 424 of the Acts of 1899, original loan,	-	$4,600,000 00
Appropriation, chapter 356 of the Acts of 1903,	-	996,000 00
Appropriations, chapters 230 and 246 of the Acts of 1904,	-	392,000 00
Proceeds from sales of property to December 31, 1904 (of which $2,722.68 is for the year 1904),	-	5,868 49
		$7,698,024 26
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1904 (of which $645,136.10 is for the year 1904),	$5,876,751 94	
		7,580,262 47
Balance South Metropolitan System, January 1, 1905,		$117,761 79

(c) *Metropolitan Sewerage Loans Sinking Fund.*

Under authority of chapter 122 of the Acts of 1899, and section 14 of chapter 424 of the Acts of 1899, the Treasurer of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan sewerage loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The sinking fund as thus established has amounted at the end of each year to sums as follows: —

December 31, 1899,	$361,416 59	December 31, 1902,	636,084 04
December 31, 1900,	454,520 57	December 31, 1903,	754,690 41
December 31, 1901,	545,668 26	December 31, 1904,	878,557 12

(2) Annual Appropriations and Receipts.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1904, have been as follows: —

North Metropolitan System.

Balance January 1, 1904,	$9,777 58
Appropriation under chapter 62 of the Acts of 1904,	123,000 00
Receipts from pumping and from other sources,	863 62
	$133,641 20
Amount approved by the Board for payment,	112,047 98
Balance January 1, 1905,	$21,593 22

South Metropolitan System.

Balance January 1, 1904,	$5,022 06
Appropriation under chapter 60 of the Acts of 1904,	135,000 00
Receipts from sales of property and from pumping,	29 30
	$140,051 36
Amount approved by the Board for payment,	139,640 88
Balance January 1, 1905,	$410 48

The Board has also received, from rentals and from other sources, to be applied by the Treasurer of the Commonwealth to the Metropolitan Sewerage Loans Sinking Fund requirements, $75.

(3) Annual Assessments.

The amounts assessed by the State Treasurer upon the cities and towns of the Metropolitan Sewerage Districts, to meet interest and sinking fund requirements and to defray the cost of maintenance and operation of works, in accordance with the ratios determined by the apportionment commissioners appointed under chapter 439 of the Acts of the year 1889 and chapter 424 of the Acts of the year 1899,* are as follows: —

North Metropolitan Sewerage System.

Arlington,	$8,091 81	Somerville,	$50,404 54
Belmont,	4,642 06	Stoneham,	4,962 06
Boston,	64,732 13	Wakefield,	7,652 70
Cambridge,	86,891 58	Winchester,	7,730 03
Chelsea,	24,449 79	Winthrop,	5,991 95
Everett,	18,355 96	Woburn,	10,712 66
Lexington,	2,483 43	Revere,	9,301 51
Malden,	28,884 84		
Medford,	17,918 64	Total,	$364,949 84
Melrose,	11,744 15		

South Metropolitan Sewerage System.

Boston,	$154,201 46	Quincy,	$24,698 31
Brookline,	53,933 77	Waltham,	25,189 36
Dedham,†	8,890 48	Watertown,	11,114 29
Hyde Park,	13,472 36		
Milton,	16,574 30	Total,	$360,696 29
Newton,	52,621 96		

* Given in previous reports. † Exclusive of Westwood.

(4) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction.	For Year ending December 31, 1904.		From Beginning of Work to December 31, 1904.	
North Metropolitan System.				
Original system, main line and branches,	$5,508 70		$5,383,932 67	
Lexington branch,	-		68,585 15	
Everett branch,	-		54,877 12	
Wakefield branch,	-		35,698 29	
Stoneham branch,	-		11,574 10	
Chelsea and Everett outlets,	-		71,016 41	
Wakefield branch extension,	-		189,883 77	
Revere extension,	153,833 37		214,451 71	
Belmont extension,	25,313 75		56,550 69	
Total North Metropolitan System,		$184,655 82		$6,086,569 91
South Metropolitan System.				
Charles River valley sewer, main line,	-			$800,046 27
Neponset River valley sewer, main line,	$50 00		$866,545 66	
Brookline branch,	100 00		36,918 60	
Total,		$150 00		903,464 26
High-level Sewer: —				
Section 43, Quincy,	$157,743 97		$401,988 99	
Section 44, Quincy,	103,894 25		290,698 78	
Section 45, Quincy,	-		76,139 36	
Section 46, Quincy,	5,681 59		61,857 20	
Section 47, Quincy,	118 00		109,786 58	
Section 48, Quincy,	49,101 13		295,319 29	
Sections 48 and 49, Quincy,	-		81,548 64	
Section 49, Quincy,	4,694 28		169,020 18	
Section 50, Quincy,	220 00		109,570 35	
Section 51, Quincy,	175 05		87,203 68	
Section 52, Quincy,	80 53		155,800 65	
Section 53, Quincy,	-		98,042 42	
Section 54, Quincy,	10 00		101,918 39	
Section 55, Quincy and Milton,	1,785 05		305,261 34	
Section 56, Milton,	128 71		105,042 50	
Section 57, Milton,	72 18		68,783 24	
Section 58, Milton,	29 85		94,089 72	
Section 59, Milton,	58 00		104,444 62	
Section 60, Milton,	89 37		60,796 18	
Section 61, Milton,	112 93		129,598 76	
Section 62, Milton,	230 76		129,557 28	
Section 63, Milton,	169 12		127,046 45	
Section 64, Neponset River crossing,	100 00		47,499 40	
Section 65, Hyde Park,	50 00		40,695 84	
Section 66, Hyde Park,	91 00		252,952 72	
Section 67, Hyde Park, Stony Brook crossing,	108 00		32,243 33	
Section 68, Hyde Park and Roxbury,	52 24		78,498 62	
Section 69, West Roxbury,	62 50		102,033 68	
Section 70, West Roxbury,	1 50		131,375 55	
Section 71, West Roxbury,	-		91,888 22	
Section 72, West Roxbury,	5,567 04		127,881 76	
Section 73, West Roxbury,	1,069 06		494,258 92	
Section 74, West Roxbury and Roxbury,	52 42		147,296 69	
Section 75, Roxbury,	2,691 31		136,192 99	
Section 76, Roxbury, cast-iron force main,	8,900 34		79,998 39	
Section 77, Roxbury, Ward Street pumping station,	275,486 61		497,024 53	
Section 78, Roxbury, connecting sewer,	4,272 49		35,844 69	
Quincy force main,	8,564 98		8,682 01	
Charles River valley studies,	3,889 71		3,889 71	
Real estate,	5,389 85		354,442 11	
Apportionment Commission,	-		2,000 00	
Administration,	4,942 33		48,543 23	
Total,		645,136 10		5,876,751 94
Total, South Metropolitan System,		$645,286 10		$7,580,262 47
Total for construction, both systems,		$829,941 92		$13,666,832 38

MAINTENANCE.	For Year ending December 31, 1904.	From Beginning of Work to December 31, 1904.
North Metropolitan System,	$112,047 98	$895,262 40
South Metropolitan System,	139,640 88	790,280 27
Total for maintenance, both systems,	$251,688 86	$1,685,542 67

(5) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1904: —

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For Year ending December 31, 1904.
North Metropolitan System — Construction.	
Commissioners,	$1,166 66
Secretary, engineer and auditor,	595 83
Clerical services,	745 33
Rent of office, Ashburton Place,	600 00
Engineering supplies,	134 41
Office supplies,	143 71
Engineers, inspectors, rodmen, laborers and others,	62,523 28
Postage, telephone and telegrams,	419 40
Books, maps, plans, blue prints and photography,	38 95
Carriage hire and travelling expenses,	366 83
Teaming and express,	197 95
Tools and repairs of same,	201 09
Brick, cement, lumber and other field supplies,	43,346 71
Contracts: —	
Jones & Meehan, old,	32 00
Revere Extension: —	
Mayo Contracting Co., Sects. 61 and 62,	9,400 07
Charles A. Haskin, Sects. 61 and 62,	37,191 58
Belmont Extension: —	
Gow & Palmer, Sect. 63,	20,276 30
Land takings, purchase and recording,	7,219 72
Experts and appraisers,	56 00
Total,	$184,655 82
Neponset River Valley Sewer — Construction.	
Contracts: —	
Edw. W. Everson, old,	$50 00
Brookline branch: —	
Experts and appraisers,	100 00
Total,	$150 00

General Character of Expenditures.	For Year ending December 31, 1904.
High-level Sewer — Construction.	
Commissioners,	$1,166 67
Secretary, engineer and auditor,	3,512 49
Clerical services,	1,236 33
Engineers, inspectors, rodmen, laborers and others,	49,224 80
Advertising,	13 88
Office supplies,	150 07
Postage, telephone and telegrams,	439 17
Books, maps, plans, blue prints and photography,	199 32
Engineering instruments and repairs of same,	5 50
Engineering supplies,	440 31
Carriage hire and travelling expenses,	1,218 99
Repairs, fittings and supplies, main office,	699 94
Rent of office, Pemberton Building,	2,812 50
Rent of office, Ashburton Place,	486 40
Rent of wharf, Quincy,	1,000 00
Teaming and express,	1,127 23
Brick, cement, lumber and other field supplies,	43,590 02
Tools and repairs of same,	1,108 79
Contracts: —	
Hiram W. Phillips, Sect. 43,	94,716 96
Camden Iron Works, Sect. 43,	56,091 28
Edward Kendall & Sons, Sect. 44,	6,315 00
Lockwood Manufacturing Co., Sect. 44,	10,932 70
Wm. H. Ellis, Sect. 44,	33,605 77
Woodbury & Leighton Co., Sect. 44,	28,440 00
Wm. H. Ellis, Sect. 46,	4,922 53
Chas. G. Belden & Co., Sect. 48,	39,748 85
Joseph J. Moebs, Sect. 48,	7,113 55
Chas. G. Belden & Co., Sect. 49,	4,312 58
E. W. Everson & Co., Sect. 62,	100 00
H. P. Nawn, Sect. 73 (part),	604 12
E. W. Everson & Co., Sect. 75 (part),	2,648 88
H. P. Nawn, Sect. 76,	7,991 23
L. P. Soule & Son, Sect. 77, building,	57,375 15
Allis-Chalmers Co., Sect. 77, pumps,	153,000 00
Lockwood Manufacturing Co., Sect. 77,	9,513 20
Camden Iron Works, Quincy force main,	7,291 67
Land takings, purchase and recording,	4,569 50
Experts and appraisers,	960 00
Legal services,	200 72
Claims and allowances on contracts,	6,250 00
Total,	$645,136 10
North Metropolitan System — Maintenance.	
Administration: —	
Commissioners, secretary, auditor and assistants,	$2,507 85
Postage, printing, stationery and office supplies,	27 18
Rent, telephone, heating, lighting and care of offices,	279 09
Miscellaneous expenses,	666 44
Amount carried forward,	$3,480 56

General Character of Expenditures.	For Year ending December 31, 1904.
Amount brought forward,	$3,480 56
North Metropolitan System — Maintenance — Concluded.	
General superintendence: —	
Engineer and assistants,	4,110 12
Postage, printing, stationery and office supplies,	83 31
Rent, telephone, heating, lighting and care of offices,	476 20
Miscellaneous expenses,	292 56
Deer Island pumping station: —	
Labor,	11,296 50
Coal,	8,863 16
Oil and waste,	444 42
Water,	1,209 60
Packing,	72 30
Repairs and renewals,	436 94
Telephones and office supplies,	337 66
Care and repairs of building and grounds, electric light plant and miscellaneous expenses,	3,388 94
East Boston pumping station: —	
Labor,	10,481 68
Coal,	9,248 14
Oil and waste,	335 04
Water,	940 80
Packing,	11 78
Repairs and renewals,	312 99
Telephones and office supplies,	303 87
Care and repairs of building and grounds, electric light plant and miscellaneous expenses,	2,751 76
Charlestown pumping station: —	
Labor,	10,326 04
Coal,	4,103 91
Oil and waste,	329 87
Water,	410 40
Packing,	76 77
Repairs and renewals,	235 92
Telephones and office supplies,	317 46
Care and repairs of building and grounds, electric light plant and miscellaneous expenses,	2,263 72
Alewife Brook pumping station: —	
Labor,	3,346 13
Coal,	1,705 61
Oil and waste,	124 75
Water,	242 40
Packing,	19 77
Repairs and renewals,	216 56
Telephones and office supplies,	160 87
Care and repairs of building and grounds, electric light plant and miscellaneous expenses,	808 24
Sewer lines, labor,	17,512 86
Supplies and expenses,	6,768 84
Horses, vehicles and stable account,	4,199 53
Total,	$112,047 98

General Character of Expenditures.	For Year ending December 31, 1904.
South Metropolitan System — Maintenance.	
Administration: —	
Commissioners, secretary, auditor and assistants,	$2,913 67
Postage, printing, stationery and office supplies,	105 47
Rent, telephone, heating, lighting and care of building,	1,003 46
Miscellaneous expenses,	680 41
General superintendence: —	
Engineer and assistants,	2,188 57
Postage, printing, stationery and office supplies,	46 43
Rent, telephone, heating, lighting and care of offices,	1,064 37
Miscellaneous expenses,	17 50
Sewer lines, labor,	14,192 35
Supplies and expenses,	6,301 68
City of Boston, for pumping and interest,	85,196 24
Quincy pumping station: —	
Labor,	3,887 42
Coal,	2,461 89
Oil and waste,	44 60
Water,	248 70
Packing,	39 84
Repairs and renewals,	241 13
Telephones and office supplies,	228 06
Care and repairs of building and grounds, lighting and miscellaneous expenses,	348 61
City of Boston, for discharge of sewage,	1,000 00
Ward Street pumping station: —	
Labor,	4,794 89
Coal,	2,139 34
Oil and waste,	402 69
Water,	126 00
Packing,	103 48
Repairs and renewals,	70 76
Telephones and office supplies,	97 13
Care of building and grounds, lighting and miscellaneous expenses,	2,520 47
Nut Island screen-house: —	
Labor,	1,180 74
Coal,	1,036 50
Oil and waste,	31 60
Packing,	15 75
Telephones and office supplies,	163 99
Care of building and grounds, lighting and miscellaneous expenses,	1,229 31
Horses, vehicles and stable account,	3,517 83
Total,	$139,640 88

(*b*) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

	For Year ending December 31, 1904.	From Beginning of Work to December 31, 1904.
North Metropolitan System, — construction,	$496 80	$17,023 53
South Metropolitan System, — construction,	2,722 68	5,977 99
North Metropolitan System, — maintenance,	863 62	5,355 53
South Metropolitan System, — maintenance,	29 30	141 86
Metropolitan Sewerage Loans Sinking Fund,	75 00	760 20
Totals,	$4,187 40	$29,259 11

(*c*) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(*d*) *Liabilities.*

There are liabilities as follows: —

Current bills unpaid,	$7,238 09
Due on monthly pay rolls,	673 89
	$7,911 98

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
North Metropolitan Construction: —		
H. A. Hanscom & Co.,	Sect. 56, held for claims,	$200 00
Chas. A. Haskin,	Sect. 61,	638 40
High-level Sewer: —		
Lockwood Manufacturing Co.,	Sect. 43, screen machinery,	1,929 30
H. W. Phillips,	Sect. 43, outlet, pipe laying,	9,705 23
Woodbury & Leighton Co.,	Sect. 44, screen-house,	1,500 00
H. P. Nawn,	Sect. 55,	1,500 00
J. W. Bustin & Co.,	Sect. 57, reserved for repairs,	100 00
E. W. & J. J. Everson,	Sect. 66,	1,000 00
National Contracting Co.,	Sect. 73, contract abandoned,	5,516 17
E. W. Everson & Co.,	Sect. 75,	2,000 00
Allis-Chalmers Co.,	Sect. 77,	51,000 00
Lockwood Manufacturing Co.,	Sect. 77,	1,678 80
		$76,767 90

On the claims of the following it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

Holyhood Cemetery Association, Mary C. Eichorn, Clemence W. Hasenfus, Jackson *et al.*, trustees, Caroline S. Skinner, heirs of John Friel, Boston Elevated Railway Company, heirs of John Gilmore, Boston & Maine Railroad, Mary Rohan, Mary E. Connolly, National Contracting Company, Jacob M. Mason, Martin Dings, Bernard Duffy, Anna L. Dunican, Edward Duffy, Joseph H. Duffy, Mary R. Duffy, William J. Duffy, Maurice Duffy, Bernard Duffy, administrator, Emma Dings, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Mary Doherty, Mary E. Doherty, Richard Jones, James Doherty, Michael Niland, Fred W. Baker, Catherine A. Baker, Walter J. Baker, Freda E. Baker.

VIII. CONSUMPTION OF WATER.

The rainfall of the year was considerably below the average, but as this deficiency occurred entirely during the last three months of the year, the yield of the watersheds constituting the sources of supply for the District was but little below the yearly average.

There was, however, a decided increase in the quantity of water consumed. The average daily rate of consumption in the cities and towns supplied by the Metropolitan Works during the year was 114,876,000 gallons, — an increase of 7,728,000 gallons over that of the preceding year. Although there was an increase in consumption throughout the year, the larger part of the increase occurred during the colder months of January, February, March and December. The daily rate of consumption per person was 123 gallons, — or 4 gallons more than the rate of the preceding year.

While the extreme cold of the winter months contributed to make a larger average consumption, the summer was unusually moderate and cool, so that there was less than the usual waste of water through the use of hand hose and lawn sprinklers, and the Board was called upon to complain of but few violations of the regulations adopted regarding their use.

IX. THE MEASUREMENT OF WATER SUPPLIED TO THE VARIOUS MUNICIPALITIES, AND THE INVESTIGATION OF UNNECESSARY AND IMPROPER USE OR WASTE.

The measurement of the water supplied to each municipality in the District which the Board was, by the installation of the Venturi meters, enabled to make during the latter half of the preceding year, has been continued throughout the past year, and the results of the measurements are given in connection with the report of the Chief Engineer.

A similar variation to that previously reported is shown in the consumption of water in the different municipalities of the District. The towns of Milton and Belmont, in which all the services are metered, and the city of Malden, in which the services are about five-sixths metered, show a daily per capita consumption respectively of 41, 49 and 46 gallons. Other municipalities in which but a small proportion of the services are metered have much greater per capita consumption, the number of gallons consumed daily per capita in the cities of Quincy, Melrose, Chelsea and Boston being respectively as high as 101, 106, 113 and 143.

The records of the Venturi meters enable the engineers and local authorities to detect the existence of leaks in the pipes, and to determine the quantities of water used otherwise than for ordinary consumption. In one municipality an increase of consumption in a single day from 400,000 to 1,000,000 gallons was recorded. This increase was found to be due to a broken 8-inch pipe, causing a leakage which might otherwise have continued for a long time without detection. The records taken likewise disclose the fact that in the whole District during the extreme cold months of January and February of the past year, between the hours of 1 and 4 in the morning when the necessary use of water was at a minimum, the actual rate of consumption for the three hours was greater than that for the entire day during the summer months. The results indicated an absolute waste in many parts of the District by reason of defective fixtures, or of allowing the water continually to run in order to avoid the freezing of the pipes.

The Legislature of last year, in acting upon the special report of the Board, by the enactment of chapter 426 of the Acts of 1904,

amended the provisions of the Metropolitan Water Act so as to provide that on and after the year 1906 the assessments upon all the municipalities of the District, other than the city of Boston, shall be laid one-third in proportion to their respective valuations and two-thirds in proportion to the quantities of water respectively consumed by them in the preceding year, thereby substituting consumption as an element of assessment, instead of population. In accordance, therefore, with this act, the measurements of water used by the cities and towns other than Boston during the current year, will be taken as important factors in determining the amounts of the assessments.

The Board is still of the opinion that a large proportion of the water now supplied to the District, amounting to from one-third to one-half of the entire quantity afforded, is unnecessarily used or wasted, and that it is possible and practicable to prevent the greater part of such unnecessary use or waste. The means of prevention are largely in the hands of the local authorities. By the introduction of meters, a rigorous inspection, and the speedy prevention of leakage and waste when discovered, a great reduction in consumption can be attained. It is still believed that both the municipality and the individual water taker can be interested in the checking of waste and excessive use by causing water rates to be largely dependent upon the quantity of water which is consumed.

X. ELECTROLYSIS.

Investigations have been continued in order to ascertain more definitely the extent of the injury done to the water pipes by the underground electric currents, and for the purpose of devising means by which such injurious effects may be overcome or largely reduced.

The most serious effects of the electric current upon the pipes have been found, as heretofore, in the vicinity of the power stations of the different electric railway companies. In one instance the iron of the pipe was so pitted and decomposed as to render hazardous its longer continuance, and the water main for a distance of 539 feet was relaid. Pipes have been uncovered and examined at various other points, but in this place only had the deterioration proceeded so far as to make necessary the immediate relaying of the pipe.

Experiments which have been made in applying to the pipes

affected an insulating covering of asphalt and burlap have not seemed to be successful. Some success has attended the installation of insulating joints in pipes which have been particularly affected, but the observations have not been carried far enough to determine to what extent the application of insulating joints will cause a reduction of electrolytic action.

The legal proceedings which have been begun to reimburse and to protect the Commonwealth on account of such injuries have been delayed to await further the results of the experiments, in which the Board has been willing to cooperate with the railway corporations.

XI. FUTURE EXTENSION OF THE HIGH-LEVEL SEWER TO BROOKLINE, BRIGHTON AND NEWTON.

The Board was authorized, by chapter 230 of the Acts of the year 1904, "to determine the location, elevation and size of the high-level metropolitan sewer above the point where the sewage from the Charles river valley is to be received," and a special appropriation for this purpose, to the amount of $7,000, was made. This act called upon the Board to make the proper surveys and investigations necessary to fix the location of this extension. The proposed extension begins at a point near Jamaica Pond in West Roxbury and proceeds northwesterly to the town of Brookline, then continues in the same general direction through that town to the Brighton line, and thence in a general westerly direction through Brighton and the city of Newton, to the Charles River.

The High-level Sewer, designed to receive only separate sewage, which extends from the connection with the Charles River valley system in the vicinity of the Ward Street pumping station in Roxbury to Nut Island and Boston harbor, was built under the provisions of chapter 424 of the Acts of the year 1899, in accordance with the recommendations made by the Metropolitan Sewerage Commission in its special report of that year upon the subject. It was stated that the Charles River valley sewer as then already constructed would probably be sufficient for a number of years to provide for portions of Brookline, Brighton and Newton; but it was within the scheme recommended that eventually an extension of the High-level Sewer would be required for these districts, and the location of such an extension was examined, and a suggested general route was traced upon the plans then submitted.

The necessity of definitely fixing the location of the local sewers which are called for by the growing population of these higher regions, especially those which are to be built for the separate system of sewerage which will in the future be required to discharge into this extension of the High-level Sewer, caused the Legislature to pass the act of last year.

The surveys and investigations have been made in accordance with the requirements of that act, and a proper location of the proposed extension has been fixed by the Engineer of the Sewerage Works and approved by the Board. The report of the Engineer, showing this location and the proposed elevation and size of the sewer, together with the estimated cost of the construction of the various sections of the work, is made a part of his general report to the Board, and is published herewith.

The route selected for the extension starts from a point in the present High-level Sewer in West Roxbury near Jamaica Pond, at the corner of Perkins and Centre streets, and, in general, proceeds by tunnel through Perkins Street, passing near Jamaica Pond and across the line into Brookline; then under Chestnut, Kendall and Cypress streets, crossing under Walnut Street, to near Boylston Street; then by open cut in a route which passes through Gorham Avenue and Park Street, by tunnel through Winchester Street, and by open cut through Columbia Street to the Brighton line. In Brighton the route passes by open cut through Columbia Street and Commonwealth Avenue, and by tunnel under Warren and Cambridge streets and a portion of Washington Street, and continues by open cut through Washington and Tremont streets to the Newton line. In Newton the route passes through Tremont Street and other short streets to Newtonville Avenue, thence by tunnel under Mt. Ida to Cabot Park, and then by tunnels and open cuts through Newtonville and West Newton to the Charles River at Newton Lower Falls.

The total length of the proposed location is 10.18 miles. About 5.30 miles are in tunnel and 4.88 miles in open cut.

Particular attention has been given to that portion of the sewer which extends from the junction of the High-level Sewer in West Roxbury through Brookline to Oak Square in Brighton. It is anticipated that the further extension through the city of Newton will not be required for a considerable period to come.

The portion of the sewer located in West Roxbury and Brookline and in Brighton to Oak Square has a length of 24,750 feet, or 4.69 miles. Although sections at various places would differ in form, its size would vary from substantial diameters of about 6 feet to 7 feet. The elevation at the highest point, at Oak Square, in Brighton, would be 41.13 feet above Boston City Base, and at the junction with the High-level Sewer, 31.5 feet above Boston City Base, or 21.5 feet above high water in Boston harbor.

The district which would be affected by the construction of this entire extension of the High-level Sewer has an area of 48.57 square miles, having an estimated population of 153,250. At present all or nearly all of the sewage of this area is contributory to the Charles River valley sewer, and the sewage thus received has to be pumped at the Ward Street station into the High-level Sewer. It is, however, estimated that an area of 20.26 square miles, having now an estimated population of 45,350, which is likely to increase largely in the future, can by the proposed extension be discharged by gravity into the High-level Sewer, and in this manner all costs for pumping can be saved.

The estimated cost of the entire extension, as given by the Engineer, is $1,889,906 ; and the cost of that portion in West Roxbury, Brookline and Brighton, which will first be required, is estimated at $1,168,928.

It is evident that the time is fast approaching when the volume of sewage discharged into the Charles River valley sewer, which provides for the territory in question, will have reached the limit of the capacity of that sewer, and that the relief which had formerly been proposed by the extension of the High-level system into the upper portions of the territory will have to be afforded.

It was estimated, when the Charles River valley sewer was built, in the year 1892, that it would provide for an anticipated population of 183,000. The present population of the district now tributary to this sewer is about 153,000, and is rapidly increasing. The maximum per capita rate of sewage, or 225 gallons a day, which was taken for the basis of the studies made previous to the year 1892, has already been exceeded in the ordinary wet weather flows. Although the Charles River valley sewer was built to receive only separate sewage from much of the territory tributary to it, in periods of storms there is necessarily a considerable increase by

ground flow and otherwise, so that at such periods the amount discharged into the sewer is now nearly equal to its capacity; and there is danger that in a comparatively few years this sewer will be at times overcharged, and the sewage will overflow so as to become offensive to portions of the District, particularly in Brighton and Brookline, through which the sewer passes. An additional advantage will be gained by the construction of the proposed extension, in that the sewage which will be received into it will be discharged by gravity, and considerable expense will be saved in the cost of pumping.

Inasmuch as the construction of the extension to Oak Square will require a period of two or three years after its building is authorized, an early consideration of the subject is important.

XII. FUTURE WORK.

The construction of the Wachusett Dam and the Wachusett Reservoir has proceeded so far that there seems but little doubt that both the dam and reservoir will in the coming year be substantially completed and made ready for use, so as to leave only some small subsidiary work to be subsequently performed.

If decided measures are taken by the municipalities of the Metropolitan District for the reduction of the present excessive consumption, the necessity of proceeding to new sources of water supply and of building further reservoirs and aqueducts will be delayed for a considerable period to come. It certainly behooves the various municipalities of the District, which have the control of the distribution of water, to promote and adopt such reasonable measures as shall postpone the necessity of providing new sources of supply and additional works therefor, and to prevent the imposition upon the people of burdens which are unnecessary.

Considerable additional work will probably be required for the abatement of sources of pollution to the water supply, for enforcing measures for stopping improper and unnecessary consumption of water through waste and leakage, and for the prevention of the deterioration of water mains arising from electrolytic action. The building of the improvement of Spot Pond Brook, called for by the legislation of last year, is dependent upon the decision of a commission to be appointed by the court. A petition for the appointment of such a commission has been made, but no action has yet been taken thereon.

With the exception of the suits of the cities of Malden, Medford and Melrose for damages on account of the taking of Spot Pond and the adjacent lands, there remain unsettled comparatively few claims for damages on account of the taking of lands for the works, for the diversion of water, for depreciation to real estate and for damages to business. It is probable that nearly all of these claims can be settled during the coming year.

The construction of the High-level Sewer and of the extensions of the North Metropolitan System of sewerage to the towns of Revere and Belmont has nearly completed all the sewerage works at present authorized. The laying of the force main from the Quincy sewerage pumping station to connect with the High-level Sewer will be accomplished early in the year.

The Board is charged with the operation and maintenance of all the various works for the supply of water to the Metropolitan District and for the disposal of the sewage. The amount required for maintenance and operation during the past year exceeded $550,000, and the putting into complete operation of the Wachusett Reservoir and of the High-level Sewer will add materially to this department of the work of the Board.

The report of the Chief Engineer, relating to the Water Works, and the report of the Engineer of the Sewerage Works, are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE.
HENRY P. WALCOTT.
JAMES A. BAILEY, Jr.

BOSTON, March 11, 1905.

REPORT OF THE CHIEF ENGINEER.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Water Works for the year ending December 31, 1904.

ORGANIZATION.

Dexter Brackett, Engineer of the Distribution Department, was on March 10 also placed in charge of the Sudbury Department and of the maintenance of the Weston Aqueduct, and on May 25 was placed in charge of completing the work of construction connected with the Weston Aqueduct. In connection with these changes he was given the title of Engineer of Sudbury and Distribution Departments.

Horace Ropes, Engineer of the Weston Aqueduct Department, after having substantially completed the work under his charge, resigned on May 25 to accept a position on the New York Water Works. The department was then abolished, and the work remaining to be done was placed in charge of Mr. Brackett, as already stated.

Charles E. Wells, Engineer of the Reservoir Department, tendered his resignation toward the end of the year, to take effect in January, 1905, in order to accept an appointment on the Reclamation Service of the United States Geological Survey; and the work of his department will on January 1 be placed in charge of Thomas F. Richardson, Engineer of the Dam and Aqueduct Department, with the new title, Engineer of Dam and Reservoir Department.

Chester W. Smith, Division Engineer and Chief Inspector at the Wachusett Dam, resigned December 10 to accept a position on the Reclamation Service of the United States Geological Survey.

Charles E. Haberstroh, Assistant Superintendent, Sudbury Department, now reports to Mr. Brackett, instead of directly to the Chief Engineer.

Charles W. Sherman, Division Engineer, tendered his resignation, which took effect September 30, to accept another position.

William W. Locke, Sanitary Inspector, who formerly reported to the department engineers, now reports directly to the Chief Engineer.

The list of assistants reporting directly to the Chief Engineer at the end of the year is as follows: —

Dexter Brackett, .	. *Engineer of Sudbury and Distribution Departments.*
Thomas F. Richardson,	. *Engineer of Dam and Aqueduct Department.*
Charles E. Wells, .	. *Engineer of Reservoir Department.*
William W. Locke, .	. *Sanitary Inspector.*
Frank T. Daniels, .	. *Principal Office Assistant.*
Samuel E. Killam, .	. *Office Assistant.*

Joseph P. Davis and Hiram F. Mills have continued as consulting engineers.

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 153, and at the end of the year 105.

In addition to the engineering force, which included the engineers engaged upon the inspection of the work, other inspectors have been employed upon masonry and earthwork. The maximum number so employed at any time during the year was 11.

Gangs of men, under the immediate direction of foremen and under the general direction of the engineers, have been employed from time to time to do minor work, the more important items of which were the grouting with cement of two large arch bridges of the Boston & Maine Railroad over the Stillwater and Quinepoxet rivers; the cleaning of a large portion of the Wachusett Reservoir, preparatory to filling it with water; cementing and otherwise treating the rock at the bottom of the cut-off trench of the South Dike; the construction of additional settling basins and beds at the Clinton sewage disposal works; and the fencing, seeding and other work connected with the completion of the Weston Aqueduct.

There has also been a maintenance force, exclusive of engineers, averaging 202, employed at the pumping stations and in connection with the maintenance of reservoirs, aqueducts, pipe lines and other work.

Force Employed on Works.

The force employed upon the works in 1904 was smaller than the force employed in 1903.

The largest force employed upon the works at any one time during the year was for the week ending June 11, as follows: —

	Men.		Horses.	
Contractors' forces: —				
Reservoir Department,	716		109	
Dam and Aqueduct Department,	911		118	
		1,627		227
Day-labor forces, construction,		171		30
Engineering force, including engineer inspectors and those engaged upon maintenance,		135		-
Inspectors not engineers,		9		-
Maintenance force, not including engineers,		190		22
		2,132		279

Arrangement of Report.

In continuing this report, it is the purpose to separate the work charged to the construction account from that charged to the maintenance account; but, as the work of construction and maintenance is supervised by the same principal engineers, and in very many cases the assistants are engaged upon both classes of work, it is not feasible to make a complete separation.

CONSTRUCTION.

Contracts.

A detailed statement of the contracts made and pending during the year is given in Appendix No. 1. The following statement gives a summary of all the contracts charged to construction from the beginning of the work to the end of the year 1904: —

Portion of Work.	Number of Contracts.	Approximate Amount.
Wachusett Reservoir,	32	$2,949,045 92
Wachusett Dam,	12	1,740,215 86
Other portions of work,	243	10,287,854 53
Totals,	287	$14,977,116 31

Amount of 6 contracts made in 1904 (approximate), ...	$95,541 26
Amount of 3 contracts unfinished December 31, 1904 (approximate),	2,388,635 00
Value of work done by contract from January 1, 1904, to December 31, 1904, ...	1,154,851 57

In the case of all contracts completed up to the present time final settlements have been made without any legal controversy.

RESERVOIR DEPARTMENT.

(The statement of the work of this department has been prepared by Charles E. Wells, Department Engineer.)

The principal work of this department during the year has been the continuation of the removal of soil from the Wachusett Reservoir and its disposal in the North Dike and in shallow flowage and highway embankments, the completion of the North Dike, the construction of highways in West Boylston and Oakdale, and the practical completion of the work connected with the relocation, raising and protection of the railroads at Oakdale.

The organization of the engineering force has been the same as during the latter part of the previous year. Charles A. Bowman, division engineer, has continued in charge of the force reports, measurements, estimates and miscellaneous engineering work connected with the removal of soil, and also in charge of maintenance and forestal work. Harry J. Morrison, division engineer, has continued in charge of the inspection of the removal of soil from the reservoir below West Boylston and the supervision of contractors. Ernest H. Baldwin, division engineer, has continued in charge of the work at and near Oakdale. Frederick W. Harris, assistant engineer, has had charge of the work at the North Dike and the miscellaneous day-labor work in that vicinity. Edwin J. Pickwick, assistant engineer, has had charge of the work connected with the relocation of roads and removal of soil at West Boylston.

The total engineering force of this department has varied in number from 57 to 47, the latter being the number at the end of the year.

The main office of this department is at Clinton. Three branch offices, two at West Boylston and one at Oakdale, have been continued throughout the year.

North Dike.

Work upon the North Dike has been in progress during the year under the contractors, the Newell & Snowling Construction Company and the McArthur Brothers Company, and is now completed.

The amount of work done during the year, also the total amount done to complete the dike, are given in the following statement: —

	To December 31, 1903.	For the Year 1904.	Total.
Soil and earth excavated from main cut-off trench (cubic yards),	499,856	-	499,856
Soil and earth excavated from secondary cut-off trench (cubic yards),	42,033	-	42,033
Total length of main cut-off trench (feet),	9,505	-	9,505
Length excavated to rock (feet),	3,130	-	3,130
Length excavated into fine sand (feet),	6,375	-	6,375
Length in which sheet piling was driven (feet),	5,239	-	5,239
Length in which sheet piling was not driven (feet),	1,136	-	1,136
Surface of rock uncovered and treated at bottom of main cut-off trench (square feet),	77,250	-	77,250
Soil from reservoir deposited in cut-off trenches and in the dike (cubic yards),	4,765,333	190,603	4,955,936
Earth and gravel taken from borrow pits and deposited in the dike (cubic yards),	198,837	6,939	205,776
Earth excavation for the construction of a small dike (coffer-dam) in Coachlace Pond (cubic yards),	19,172	-	19,172
Drain pipe laid at toe of westerly portion of dike (linear feet),	7,083	-	7,083
Screened gravel on the water slope of the dike as a foundation for riprap (cubic yards),	14,355	1,556	15,911
Riprap on the water slope of the dike (cubic yards),	81,359	41,771	123,130

The dike covers an area of 135 acres and contains 5,300,753 cubic yards of material brought from outside sources. In addition, 561,061 cubic yards of earth were excavated from cut-off trenches and for a small dike, making a total of 5,861,814 cubic yards of earth moved in connection with the construction of the dike. The dike is 10,400 feet or nearly 2 miles long on the water side at full-reservoir level, 65 feet high at the deepest place up to this level, and 1,930 feet wide at the base at the maximum section.

The depositing of screened gravel as a foundation for the riprap on the westerly portion of the dike was completed April 13, 1904. The soil filling, constituting the principal part of the dike, and consisting of a total of 4,955,936 cubic yards, was completed November 12. The placing of riprap was completed November 18.

The total cost of the dike is substantially $750,000, which may be subdivided by classes of work, as follows: —

Soil excavated from the reservoir and deposited at the North Dike, only the estimated cost of depositing it being charged to the dike, 4,956,000 cubic yards, at 5 cents,	$247,800
Excavation from cut-off trench, 542,000 cubic yards, at 18 cents,	97,560
Borrowed earth, 225,000 cubic yards, at 22 cents,	49,500
Riprap and screened gravel, 139,000 cubic yards, at 64 cents,	88,960
Drain pipe and other miscellaneous items,	11,180
Sheet piling, treatment of ledge in bottom of cut-off trench, pumping, consolidating soil with water and other day-labor work,	125,000
	$620,000
Engineering and preliminary investigations,	130,000
	$750,000

A day-labor force has been employed in finishing the slope of the dike toward the water on the easterly and westerly portions and seeding the slope of the easterly portion; lumber and tools have been removed to the Wilson Street storage yard; weeds have been mowed and burned; and nine permanent benches have been placed on the easterly portion of the dike, for the purpose of determining future settlement of the material composing the dike.

The maximum day-labor force employed at the dike was 10 men and 4 horses, for the week ending June 25.

Measurements have been made during the past three years which give interesting and important information, confirming that previously obtained with regard to the impermeability of the soil which has been used for the construction of the greater portion of the North Dike.

A small well was sunk on the down-stream slope of the dike, about 1,200 feet distant from the crest of the dike and about 500 feet from the toe. The surface of the dike at the well is about 25 feet above the high-water level of a pond at the toe of the dike, and this pond is drawn down during the summer from 4 to 6 feet below the high-water level.

During the time of these observations the Wachusett Reservoir had not been filled against the up-stream face of the dike, so that the water on that face was somewhat lower than at the down-stream toe. Notwithstanding this fact, the water in the well stands from 18 to 24 feet — averaging about 22 feet — higher than the water in the pond at the toe of the dike.

The soil, although merely dumped from cars in layers 7½ feet in

thickness, is so nearly impervious that the rainfall alone is able to maintain the ground water in this portion of the dike only a few feet below the surface of the down-stream slope.

The elevation of the water in the well rises after each heavy rain, and also shows a seasonal change, being higher after the spring floods and lower after the summer and autumn droughts. The water when highest was 2 feet below the surface of the dike, and when lowest 7 feet below.

Not only were the observations made at the well, but on two occasions, November 9, 1903, and April 21, 1904, were also made at points 25 feet apart in each direction, covering an area 400 feet long in the direction of the slope and 250 feet at right angles thereto in the vicinity of the well. These observations showed that the ground water was from 3 to 7 feet below the surface of the dike (which has a slope of from 3 to 4 feet in 100) and approximately parallel with it.

Relocation and Construction of Roads.

Considerable progress has been made by the contractors on the construction of highways at West Boylston and Oakdale.

Of the new highway which passes through Oakdale, that part between Pleasant Street and the village was opened for travel on June 15, and the remainder, to a point south of the Quinepoxet arches, on September 17.

Considerable work has also been done on Newton Street, south of the arches, and on the new location of Holden Street, which is now used for public travel. The highway across the reservoir at West Boylston was opened for public travel on December 24. The opening of these highways has permitted the discontinuance of the last of the public railroad crossings at grade in the villages of Oakdale and West Boylston.

Additional information with regard to the work on the highways mentioned may be found subsequently in this report, under the head of Contracts.

In addition to the work done by the contractors, there has been done by the day-labor forces a considerable amount of work, such as grading and seeding highway slopes; erecting and painting highway railings between West Boylston and Oakdale; constructing the false works for the arch bridge at the West Boylston crossing of the

reservoir, and removing the same; constructing pipe highway culverts at the South Meadow Road, Clinton, and near the West Boylston railroad station; and constructing concrete highway culverts under Holden Street and at Malden Brook on Newton Street, Oakdale.

The maximum force employed was 23 men and 6 horses, for the week ending October 29.

Removal of Soil.

Work upon the removal of soil from the reservoir has been in progress under the contractors, the Newell and Snowling Construction Company, and Bruno, Salomone & Petitti. More detailed information in regard to each contract will be found under the head of Contracts.

The total amount of soil removed and to be removed from the Wachusett Reservoir is at present estimated to be about 6,900,000 cubic yards, from approximately 3,943 acres. Of this, the total amount removed from the reservoir in previous years was 5,645,064 cubic yards, from 3,236 acres; in 1904, 1,115,341 cubic yards were removed from 621 acres, making a total from the beginning of the work to the end of 1904 of 6,760,405 cubic yards, or 98 per cent. of the total as at present estimated, removed from 3,857 acres.

The above total includes 160,895 cubic yards of soil stripped under contracts Nos. 273 and 275 (Dam and Aqueduct Department), from 101.4 acres near South Clinton, and 7,500 cubic yards stripped from the vicinity of the Wachusett Dam.

Of the soil removed to the end of 1904, 470,233 cubic yards were used for road embankments, 1,026,754 cubic yards for shallow flowage areas, 131,781 cubic yards for railroad embankments, 4,955,936 cubic yards for the North Dike, 160,895 cubic yards for the South Dike, 7,306 cubic yards have been placed in spoil banks and 7,500 cubic yards have been used near the Wachusett Dam. During the year 8,835 cubic yards of earth have been deposited upon the deep muck, which has been covered to a depth of about 1 foot. This amount, added to 230,011 cubic yards used for the same purpose during previous years, gives a total of 238,846 cubic yards.

The day-labor forces under the direction of the engineering force have performed the following work: —

All of the bodies from the old Beaman Cemetery have been removed to a new burial lot adjoining the West Boylston Cemetery. The new lot was graded and seeded, a gravel drive was constructed, and a substantial wall enclosing the lot was built. Excavation was carried to a depth of about 7 feet over the whole area of the old cemetery, and 65 bodies were removed. These were placed in boxes provided for the purpose, and reinterred in the new lot. The monuments, head-stones and foot-stones were removed and erected in their proper places. The excavated material was removed to the shallow flowage embankment opposite the Clarendon Mills. The work of removing the bodies was commenced on May 10 and completed on May 21.

The final cleaning of the reservoir bottom on the area to be flooded was accomplished to elevation 375. The weeds and grass were removed, and, together with the roots, etc., were burned over an area of 1,200 acres. On a considerable portion, where there was a growth of bunch grass, the ground was harrowed over with spring-tooth harrows. The grass was afterwards raked and burned. This method was somewhat more costly than mowing and raking the grass, but the results were more satisfactory.

Stumps and driftwood were removed from the channels of the Stillwater, Quinepoxet and Nashua rivers, between Oakdale and a point about 1 mile below West Boylston. This material was piled and burned. Perennials were pulled or grubbed on the portions of the reservoir from which the soil has been removed; the reservoir margin has been widened in the vicinity of Dover Pond, and also near West Boylston; driftwood has been removed from the reservoir, and burned; soil on the old Central Massachusetts Railroad embankments at Oakdale has been cast to the foot of the slopes, and covered; the bottom of the reservoir in the vicinity of the upper end has been graded, to secure proper drainage; and much other miscellaneous work has been done.

The maximum force employed was 62 men and 6 horses, for the week ending October 1.

In addition to the engineering work connected with the estimates and inspection of the removal of soil, the organic matter in 1,035 samples of soil has been determined for the guidance of the inspectors.

WACHUSETT RESERVOIR—WEST BOYLSTON MANUFACTURING COMPANY MILLS SITE BEFORE BEGINNING OF WORK AND AFTER STRIPPING OF RESERVOIR AND CONSTRUCTION OF ARCH AND EMBANKMENT.

Relocation of Railroads.

The principal part of the contract work upon the relocation of railroads was completed in 1903. Some paving has been done on the slopes of the Worcester, Nashua & Portland Division during the season of 1904, and a very small amount yet remains to be done in the vicinity of the Stillwater and Quinepoxet arches. The Boston & Maine Railroad has raised and ballasted the track on the Worcester, Nashua & Portland Division south of the Oakdale station, and has also raised and ballasted the Y track connecting the Worcester, Nashua & Portland and Central Massachusetts divisions.

The principal day-labor work in connection with the railroads has been the grouting of the masonry of the arches which carry the railroad over the Quinepoxet and Stillwater rivers, and the relaying of a considerable part of the wingwalls. This work became necessary because the wingwalls and portions of the abutments were originally laid without mortar, and, with the raising of the water in the reservoir against them, they might otherwise have failed. The waterway of the Quinepoxet arch was paved in 1902, and that of the Stillwater arch in 1903. The work of grouting the masonry and relaying the wingwalls was commenced at the Stillwater arch on June 6, 1904. A steam derrick was used to handle the materials of construction. The upper and insecure parts of the wingwalls were taken down, and when rebuilt the walls were extended to correspond with the slopes of the embankments. In rebuilding as much additional stone as was necessary was provided and all of the stone was laid in Portland cement mortar. It was necessary to take down and relay a large part of one of the wingwalls at the Stillwater arch. The grouting of the main parts of the walls proceeded at the same time. All joints were thoroughly washed out with a stream of water furnished by a steam pump through a 1-inch hose. The joints were then carefully filled at the face of the walls with rich mortar, holes being left about 5 feet apart for convenience in grouting. The filling of the joints was done a few days in advance of the grouting. A specially constructed funnel, having a spout on the side, was used in pouring the grout into the walls. The grout was prepared in an ordinary mortar box, and was composed of 3 parts of fine sand to 1 part of American Portland cement. Five or six men did the mixing with mortar hoes, and when the grout was of proper

consistency, three men continued stirring the mixture while the others poured the grout into the walls. Ordinary coal hods were used in transferring the grout to the wall, the hods being filled by means of coal scoops. Substantial stagings were erected as the work progressed, and the mixing box was always kept on a level with the work and close to the wall where the grout was being used. The grout ran very freely, in some cases showing in the walls at a distance of 75 feet from the point of application. Four hundred and eighty cubic yards of rubble masonry were laid, at a cost of $4.86 per cubic yard. This includes the expense of removing the old masonry and excavating for foundations at the ends of the walls. One thousand seven hundred and thirty barrels of cement were used in the grouting, at a cost of $3 per barrel of cement. A total of 2,041 barrels of cement were used for the rubble masonry and grouting of both arches. This work was completed November 19, the Quinepoxet arch being finished at that time. The maximum force employed was 26 men and 5 horses.

The maximum day-labor force employed on the relocation of railroads was 28 men and 4 horses, for the weeks ending October 8 and 29.

Contracts, Wachusett Reservoir.

Contract 210, Newell & Snowling Construction Company.

Excavating Soil from Section 8 of the Wachusett Reservoir, and building a Part of the Westerly Portion of the North Dike, in Clinton and Sterling.

On August 1, 1901, a contract was made with the Newell & Snowling Construction Company for removing soil from Section 8 to the westerly portion of the North Dike. This contract called for the removal of a sufficient amount of soil to complete this portion of the dike, and also for the excavation of earth and gravel for the completion of the embankment along the water slope of the dike, and for the covering with sand or gravel of deep muck which it was not considered desirable to remove. A subsequent agreement was made with the contractors on May 13, 1903, for the placing of a layer of screened gravel from 6 to 18 inches in depth on the slope of the westerly portion of the dike, as a foundation for riprap.

The operations of the contractor were continued along the same lines as during the preceding seasons. Soil has been loaded into carts and deposited in a shallow flowage embankment nearly opposite the former location of Sawyer's Mills. The remainder of the

soil has been loaded into carts and, by means of dumping platforms into cars, or has been loaded directly into cars, and hauled by locomotives to the North Dike. A limited area of muck has been covered with earth to a depth of about 1 foot. The placing of screened gravel on the slope of the westerly portion of the dike was in progress at the close of 1903, and was completed April 13, 1904. The last soil was hauled to the dike November 1.

By the operation of the railway and car plant, 57,427 carloads, containing 188,772 cubic yards, were transported to the dike; this, added to the 180,513 carloads, containing 620,131 cubic yards, transported during previous years, makes a total of 237,940 carloads, containing 808,903 cubic yards, transported under this contract.

The plant consisted of 2 12-ton locomotives, 60 3-cubic-yard dump cars and 5 miles of 3-foot-gage track.

The total amount of work done has been: —

	To December 31, 1903.	In 1904.	Total.
Clearing and grubbing (acres),	298	107	405
Soil excavation (cubic yards),	696,245	274,503	970,748
Earth excavation for embankment at dike (cubic yards),	14,915	2,163	17,078
Earth excavation for covering (cubic yards),	55,245	4,479	59,724
Gravel excavation for water slope of dike (cubic yards),	29,037	4,776	33,813
Screened gravel for foundation for riprap (cubic yards),	6,776	1,556	8,332

The amount of the final estimate was $395,092.50.

The work was completed November 26.

The maximum force employed was 184 men and 38 horses, for the week ending May 21.

Contract 257, Bruno, Salomone & Petitti.

Section 10 of the Wachusett Reservoir, in Boylston and West Boylston.

On December 27, 1902, a contract was made with Bruno, Salomone & Petitti for the construction of what is known as Section 10 of the Wachusett Reservoir. This contract calls for clearing, grubbing and excavating soil from some 700 acres toward the upper end of the reservoir. At the beginning of 1904 it included all of the soil stripping necessary to complete the reservoir, excepting

that covered by contracts of the Newell & Snowling Construction Company, John F. Magee & Co., and a comparatively small area along the Stillwater River at the upper end of the reservoir which has not yet been placed under contract. It also provided for the construction of a new channel, chiefly in rock, for the Nashua River at the highway crossing of the reservoir at West Boylston; enlarging a portion of the channel of the Quinepoxet River west of the Worcester, Nashua & Portland Division at Oakdale; building a concrete dam across the river at the upper end of this channel; paving the slopes of the railroad and highway embankments; excavating gravel to be used for protecting the slopes of embankments; and covering with earth deep deposits of muck not desirable to remove. The progress of the work was considerably in excess of the requirements of the contract at the beginning of 1904.

The methods employed by the contractors have been the same as in use during the preceding season. The soil from limited areas in the vicinity of shallow flowage and highway embankments has been loaded into carts and hauled directly to the embankments. A limited amount of soil has been placed in spoil banks. On other portions of the work, requiring a longer haul, the soil has been loaded into carts and, by means of dumping platforms into cars, or has been loaded directly into cars, and hauled to the embankments at West Boylston or Oakdale, or to the shallow flowage embankments at Oakdale.

The total number of carloads of soil hauled during the year has been 182,889, containing 580,254 cubic yards; this, added to 138,543 carloads, containing 429,617 cubic yards, hauled during 1903, makes a total of 321,432 carloads, containing 1,009,871 cubic yards.

Of the soil removed under this contract, 268,378 cubic yards were used in highway embankments, 917,524 cubic yards were used in shallow flowage embankments near Oakdale and 7,306 cubic yards were deposited in spoil banks.

The railroad plant consisted of 6 12-ton locomotives, 1 10-ton locomotive, 80 $2\frac{1}{2}$-cubic-yard dump cars, 40 3-cubic-yard dump cars, 40 $3\frac{1}{2}$-cubic-yard dump cars and 8.4 miles of 3-foot-gage track.

The work of soil removal has been prosecuted vigorously during the season. Considerable earth excavation has been done in the new channel for the river above the Quinepoxet arches at Oakdale,

and the slopes have been paved. The highway embankments at Oakdale and West Boylston have been completed. The slope paving is completed on the highway embankments at Oakdale, and, with the exception of a small amount, is completed on the Worcester Street embankment at West Boylston. The excavation of the rock channel at West Boylston was completed and the water of the Nashua River turned through the channel on July 16.

The total amount of work done under this contract has been: —

	To December 31, 1903.	For the Year 1904.	Total to December 31, 1904.
Clearing and grubbing (acres),	67	87	154
Soil excavation (cubic yards),	496,261	696,947	1,193,208
Earth excavation (cubic yards),	38,463	52,386	90,849
Rock excavation (cubic yards),	4,917	12,026	16,943
Slope paving (cubic yards),	8,362	10,630	18,992

This contract provided for the completion of the work on or before November 1, 1905; but in view of the importance of having the reservoir in readiness for the storage of large quantities of water in the spring of 1905, a bonus was offered for the completion at the end of 1904 of those portions of the work more than 15 feet below the full-reservoir level. This bonus has been earned by the contractors, notwithstanding that the number of cubic yards of soil removed was considerably in excess of the number in the preliminary estimate of quantities of work to be done.

The maximum force employed has been 556 men and 107 horses, for the week ending September 10.

Contract 268, McArthur Brothers Company.

Placing Riprap on the Westerly Portion of the North Dike, in Clinton and Sterling.

On May 16, 1903, a contract was made with the McArthur Brothers Company for using as riprap, on the westerly portion of the North Dike, granite to be excavated from the waste channel of the Wachusett Dam and in preparing the foundations for the dam, and a comparatively small amount of granite already excavated. The cross-section of the riprap and the methods of the contractor were for the greater part of the season the same as those described in the last annual report. About October 1 the work had advanced

to the westerly end of the dike, and the derrick which had been used in placing the riprap was then removed. A considerable quantity of coarse riprap was then required at different places along the dike, where it had been omitted on account of the difficulty in procuring a sufficient proportion of the large stone from the excavations at the dam as the work on the dike progressed. After the removal of the derrick the cars were dumped and the stone placed entirely by laborers. The work was completed and the contractor's plant removed November 18. The total amount of riprap placed was 25,063 cubic yards; this quantity, added to the 15,751 cubic yards previously placed, makes a total of 40,814 cubic yards. These quantities represent the amount of solid rock used for the riprap, which, when in place as riprap, swelled to a volume two-thirds greater.

The amount of the final estimate was $51,017.50.

The maximum force employed was 16 men, for the week ending February 27.

Contract 277, F. A. McCauliff.

Masonry Arch Bridge at West Boylston.

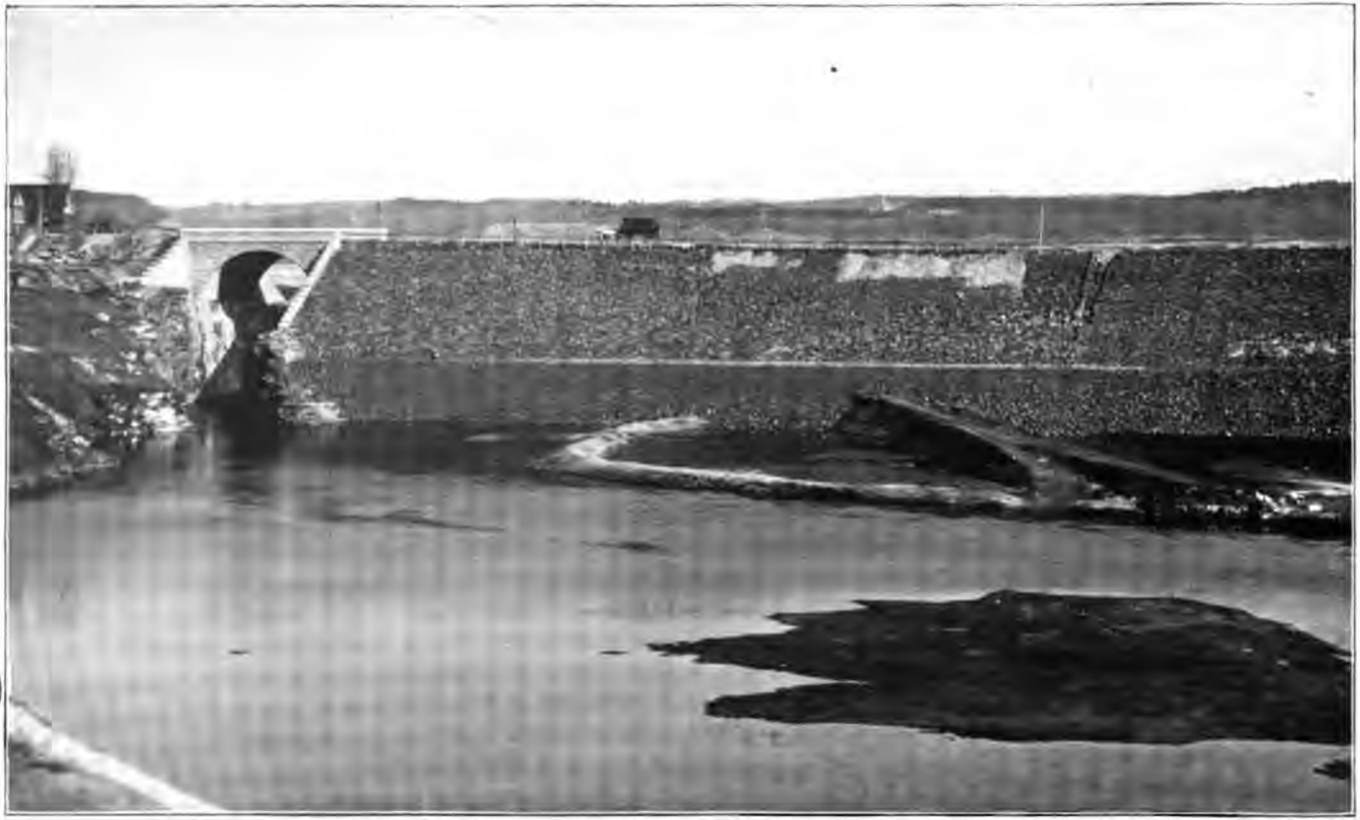
On June 23, 1904, a contract was made with F. A. McCauliff for the construction of a masonry arch bridge at the highway crossing the reservoir at West Boylston. This contract called for the construction of a granite masonry arch highway bridge and wingwalls backed with concrete. The arch was to span a deep rock cut which had been excavated for the purpose of making a new channel for the Nashua River. The Board was to furnish the material for and erect and remove the false works on which the arch was to be built, and to prepare the foundations for the arch and wingwalls. Work was commenced on July 18 and completed in a satisfactory manner on September 28, two days ahead of the time required by the contract.

The principal quantities of work performed were as follows: —

Concrete masonry (cubic yards),	724
Ashlar masonry (cubic yards),	498
Face dressing of fine-pointed work (square feet),	1,096
Face dressing of rough-pointed work (square feet),	400

The value of the work, as shown by the final estimate, was $12,809.65.

The maximum force employed was 38 men and 8 horses, for the week ending September 24.



WACHUSETT RESERVOIR—ARCH BRIDGE OVER THE NEW CHANNEL, AND HIGHWAY EMBANKMENT ACROSS RESERVOIR AT WEST BOYLSTON.

Improving Wachusett Watershed.

The dam at the Palmer mill-pond in Sterling was removed, and a main ditch 1,550 feet long and 4 feet wide on the bottom was dug to make a new channel for the brook running through it. Side ditches having an aggregate length of 1,365 feet were also dug for draining the site of the pond. Considerable other work has also been done by day-labor forces in constructing cesspools, privies and filter-beds.

Forestry.

The cutting out, grading, draining and improving of interior roads has been continued. About 3 miles of these roads have been treated in this manner, for purposes of fire protection and forestry improvement. The work of cutting out mature, dead and undesirable trees, preparatory to planting, has been done over about 200 acres. About 200 acres have been planted with three and four year old white pine seedlings grown in the nurseries of the Board. This area consisted of arable land, open and brushy pasture and sprout land which had been burned over, or on which there was little but an undesirable scrub growth.

On the open areas pines were set at 10-foot intervals, with sugar maples between as fillers. These maples were natural seedlings obtained at the Lamson farm. Hickory nuts and acorns were planted to provide fillers on the brushy areas. On some partly forested areas pines only were planted, varying the intervals from 5 to 10 or more feet, according to the existing growth. Three rows of white pines 6 feet apart each way were planted along 2 miles of the southern reservoir margin near Pine Hill; 123,900 pines, 89,700 sugar maples, 7¾ bushels of hickory nuts and 4 bushels of acorns were planted.

The necessary care has been given to the Flagg and Lamson nurseries during the year. There were transplanted from seed beds to nursery rows at the Flagg nursery 23,000 two-year-old white pines. This nursery now contains 123,500 three and four year old white pines and 24,000 two-year-old pines in nursery rows. The seed beds contain approximately 23,000 white pines, 14,000 Norway spruces and 300,000 arbor vitæ, all two years old. They also contain, from seed sown in May, 1904, 105,000 white pines, 11,000 Douglas spruces, 3,000 hemlocks, 38,000 white spruces, 4,000 tamaracks, 1,000 European larches and 10,000 Scotch pines.

The Lamson nursery contains about 12,000 three, four and five year old white pines. There have been taken up and heeled in for spring planting 19,000 pines and 22,000 natural seedling sugar maples.

Furrows for fire protection have been plowed around all the areas planted this year, and replowed around areas previously planted and on fire guards where necessary.

Pine trees from the nursery, together with larger ones taken from pasture land, were planted to form a screen around the filter-beds at the Worcester County Truant School.

Engineering.

In addition to the engineering work already enumerated, and that necessarily connected with the contract and day-labor work in progress, the engineering force of the Reservoir Department has performed the following work: —

Plans, specifications and estimates have been prepared for the construction of a new highway on the southerly side of the reservoir between Oakdale and West Boylston; elevations on the reservoir bottom, as determined by the final levels taken after the completion of soil excavation, have been entered on record sheets and contour lines have been drawn covering an area of about 430 acres, making a total of 2,500 acres covered by these final records at the end of the year. Curves were plotted and tables prepared showing the capacity of the reservoir at each tenth of a foot between elevations 305 and 332. Surveys and plans were made of the Warfield estate in Holden and West Boylston, and of the Dorr property in Holden. Plans have been made for the discontinuance of parts of Newton and Pleasant streets at West Boylston, and for the discontinuance of Holden Street at Oakdale. Plans have been revised for the relocation of Holden and Newton streets at Oakdale. In addition to the surveys and plans mentioned, many others have been made in connection with the settlement of claims and for other purposes, and much miscellaneous engineering work has been done.

DAM AND AQUEDUCT DEPARTMENT.

(The statement of the work of this department has been prepared by Thomas F. Richardson, Department Engineer.)

The principal work of this department has been the construction of the Wachusett Dam and of the superstructure of the lower gate-chamber of the dam, the construction of the South Dike and the

removal of soil from the Wachusett Reservoir near South Clinton. The department has also had charge of the operation of the Wachusett Aqueduct and the Clinton sewage-disposal system.

The organization of the force has continued practically the same as during the previous year. Chester W. Smith, division engineer, continued in charge of the work at the Wachusett Dam until December 10, when he resigned to accept a position in charge of the Roosevelt Dam, near Phoenix, Ariz., for the Reclamation Service of the United States Geological Survey. Mr. Smith, in addition to his duties as division engineer, acted as chief inspector at the dam during the progress of masonry construction. Moses J. Look, division engineer, has had charge of the construction of the South Dike and of the removal of soil near South Clinton. The work in the drafting office has been in charge of Allen E. Shannan. Elliot R. B. Allardice has continued in charge of the river and aqueduct gagings, and has direct supervision of the maintenance of the Clinton sewerage plant. He has also had charge of the construction of some extensions to the Clinton sewage disposal system, which have been built by day labor during the year.

The engineering force has averaged 24 men for the whole year; there were also 10 masonry inspectors.

The main office of the department is in Clinton, and a branch office has been maintained at the Wachusett Dam.

Wachusett Dam.

The design of the Wachusett Dam and the contract for its construction, which was made with the McArthur Brothers Company on October 1, 1900, were described in the annual report of January 1, 1901. The plant provided for the work, and the methods of carrying on the work, both at the quarry and at the dam, were fully described in the annual report of January 1, 1902. There has been no material change in the plant or in the methods.

The work was carried on without interruption from the beginning of the year until December 24, when practically all work was shut down for the winter. Work upon the masonry, which was suspended on account of cold weather on December 8, 1903, was not resumed until March 24, and was again suspended on November 28. The progress on the work has been good, about 10,000 cubic yards more masonry having been laid during the past year than during any

previous year. The work is considerably behind the requirements of the contract, which provides for the completion of the whole work on November 15, 1904. The dam has, however, been carried to a sufficient height to permit the storage in the reservoir of as much water as it will be feasible to store next spring. Rather more than 15,000 cubic yards of masonry still remain to be built, out of a total of 273,000 cubic yards, — an amount of work which can easily be accomplished during the coming season.

Industrial conditions have been favorable during 1904, and both common and skilled labor have been plentiful. Sufficient supplies of all kinds have been readily obtainable.

Main Dam, Gate-chambers and Terminal Structures.

When work upon the masonry was suspended in 1903, the masonry extended across the valley for a length of 739 feet, and the top of the masonry was at an average elevation of 345, or about 79 feet above the original river bed. Short masonry cut-off walls had been built at both ends of the masonry from the up-stream face of the dam to the ledge rock, to prevent water from going around the low ends. The lowest point in the masonry of the dam between the cut-off walls was at about elevation 341. The substructure of the lower gate-chamber had been built, and four 48-inch valves for controlling the flow of the water into the river below the dam, and eight 24-inch valves for controlling the flow of the water into the Wachusett Aqueduct, had been placed in this substructure.

Excavation. — When masonry work was discontinued in December, 1903, the excavation at the easterly end had been extended close up to the tracks over which stone is brought from the quarry, and these tracks were as near as possible to the cableway towers. As soon as the masonry work was suspended the tracks were removed, and later were carried across the dam on a timber trestle about 25 feet high, which rested on the masonry which had already been built. Preparations were also made to increase the span of both cableways from 1,150 feet to 1,250 feet. New tracks for the head towers were built 100 feet back of the previous tracks, and 21 feet higher. The head towers were then raised by means of screw jacks, and moved on building movers' rolls to these tracks, the cables and other ropes being taken off the towers while they were being moved. The removal of the first tower was completed on February 4, and of the

other on February 27. The new tracks on which the cableways move up and down the valley were reduced in length from 500 feet, as originally built, to 150 feet.

As soon as the tracks over which stone is brought were removed, the work of excavation was resumed and was continued until July 9, when the excavation for the dam at the easterly end was completed. Some of the earth removed was used to fill the trench for the dam near the easterly end of the masonry, and the remainder was passed by derricks to the cableways, and dumped both above and below the dam on the westerly side of the valley. Considerable of the earth from between the cableway towers was placed back of the towers to form the road-bed for the new cableway tracks. In filling above the dam on the easterly side of the river, special precautions were adopted during cold weather to ensure a water-tight filling. Arrangements were made so that the earth filling would be puddled by dumping into water, this water being heated by the steam from two boilers, so as to remove any frost that there might be in the earth. The rock removed was placed outside of the earth, both above and below the dam, at the easterly end, and was used for grading the grounds below the dam.

The earth overlying the rock had a depth of about 35 feet, and was a boulder clay so hard and compact that it was found economical to loosen it by blasting. The rock uncovered was a soft black or gray schist, and the average depth of the excavation in the rock under the whole base of the dam was about 9 feet. In addition, a cut-off trench 20 feet wide was excavated to a depth of about 15 feet in the black schist, which was practically impervious to water. This cut-off trench extended a short distance under the abutment.

At the westerly end of the dam the excavation of earth and rock was substantially finished in 1903, except the westerly 40 feet of the cut-off trench in the rock. This trench, which is 20 feet wide under the main dam, was narrowed somewhat as it passed through the site of the bastion, and has a width of 17 feet at the junction with the waste-weir. The rock under the bastion was a hard granite, which was less seamy than the rock toward the lower part of the valley. It was consequently necessary to excavate this part of the cut-off trench only to a depth of 10 feet to reach rock practically free from seams, and the work was finished in May.

In excavating the cut-off trench on both sides of the valley, the method adopted in previous years, and described in the annual report of January 1, 1902, of drilling 3-inch holes 6 inches apart on both sides of the trench, was followed.

Masonry. — As previously stated, masonry construction was in progress from March 21 to November 28. When masonry work was suspended, the main dam had an average elevation of 396, equivalent to 1 foot above full-reservoir level, 130 feet above the original river bed and 188 feet above the lowest point of the foundation not in the cut-off trench. A gap about 20 feet wide, through which pass two tracks over which stone is brought from the quarry, has been left through the masonry, the bottom of this gap being at about elevation 369. If necessary, this gap can readily be built up with masonry in the early spring, so that water can be stored to elevation 380. A few of the coping stones of the dam have been set at the easterly end, near the abutment. The total length of the dam is 1,476 feet, made up of waste-weir, 452 feet; main dam, including the terminal structures, 971 feet; and corewall, which extends beyond the terminal structure at the easterly end, 53 feet. The length of the dam between terminal structures is 838 feet. The rubble-stone masonry down stream from the centre line of the dam was laid as before, with beds inclined upward 1 in 6 toward the down-stream face, until the masonry reached elevation 370. Above this elevation all of this class of masonry has been laid with practically horizontal beds.

A large part of the terminal structure at the easterly end of the dam, which is known as the abutment, has been built, some of the string course stone at elevation 415 having been set. The section of the rubble masonry corewall which was built in 1903 has been extended so as to connect with the abutment. The 6 concrete piers for supporting the floor of the abutment have been partially built. About 137 feet of the retaining wall, extending 200 feet up stream from the abutment, have been completed.

The top of the masonry at the upper gate-chamber is at elevation 396. Six ports or openings have been constructed to each of the 4 wells in the upper gate-chamber. These ports are between elevations 330 and 390, and will admit water to the 48-inch pipes through the dam. Eight sluice gates, each 6 feet high and 2.5 feet wide, which will regulate the flow of water through the dam, have been

placed in the wells in the upper gate-chamber, and the gate stands for operating these gates have been set in a temporary manner.

The masonry of the terminal structure at the westerly end of the main dam, which is known as the bastion, has been built to elevation 404.

Waste Channel and Waste-weir.

Work has been in progress excavating rock from the waste channel for nearly the whole year, most of the rock excavated being hauled to the westerly portion of the North Dike, a distance of about 2 miles, to be used as riprap. After November 17 the rock was used as filling below the bastion and as riprap above the dam. During the early part of the year the work done was in the upper part of the waste channel in front of the waste-weir, where a channel of varying width and depth, but averaging about 70 feet wide and 6 feet deep, was excavated in the rock in order to furnish sufficient waterway to remove the water which may flow over the waste-weir. This channel is narrower and deeper where it passes under the location of the permanent line of the Central Massachusetts Railroad, the rock excavation being about 50 feet wide and 20 feet deep at this point. Most of the rock and all of the earth in the waste channel have been excavated, except that under the temporary location of the Central Massachusetts Railroad, which cannot be removed until the railroad is changed to its permanent location.

The earth excavation was largely finished during 1903, but a small amount of earth has been excavated near the upper end, and used for filling below the bastion. The earth slopes of the waste channel below the railroad crossing have been trimmed, and on the southerly side have been covered with soil and seeded. Some soil has been delivered on the northerly side of the channel, but has not been placed on the slopes.

The 24-inch cast-iron pipe which supplies the Lancaster Mills with water crosses the waste channel near its lower end, and the bottom of the pipe as originally laid was at the same level as the bottom of the waste channel. To ensure the safety of this pipe when water is running in the waste channel, it has been placed in a trench 5 feet deep, excavated in the rock which forms the bottom of the channel. In refilling this trench, the upper 18 inches was filled with Portland cement concrete.

At the site of the waste-weir, the rock, most of which had been

uncovered the preceding year, was found to be freer from seams than in the lower part of the valley. This, together with the fact that for most of the length of the waste-weir the flow line of the reservoir is 15 feet or less above the surface of the rock below the masonry, has made it necessary to excavate but very little rock to obtain a suitable foundation. For about 165 feet from the bastion a cut-off trench 10 feet wide and about 8 feet deep was excavated under the up-stream portion of the waste-weir. In excavating this trench, 3-inch holes 6 inches on centres were drilled on the down-stream side of the trench for most of the distance. The rock from the trench was then removed, largely by blasting, but care was taken to disturb as little as possible the lower side of the trench. Under the remaining 285 feet of the waste-weir the rock was prepared for the masonry by barring and wedging, rather more than 2 feet of rock on an average being removed, though in one place it was necessary to remove over 6 feet of rotten rock before obtaining a suitable foundation.

Masonry of Waste-weir and Retaining Wall.

Work was begun on masonry at the waste-weir early in June, and about 390 linear feet have been completed, leaving 60 linear feet still to be built, but the part remaining to be built is only about 7 feet high. No masonry work has been done on the small abutment at the westerly end of the waste-weir.

Extending along the easterly side of the waste channel from the bastion, to and beyond the arch bridge which will carry the tracks of the Central Massachusetts Railroad across the waste channel, is a retaining wall which has a height of over 26 feet above the bottom of the channel near the bastion; 195 linear feet of the higher part of this wall have been finished. Immediately below the waste-weir and against the retaining wall the ledge rock was lower than the surrounding rock in the waste channel. This hole has been filled, partly with rubble masonry, covered with ashlar paving 2 feet thick, and partly with Portland cement concrete masonry. The paving is $22\frac{1}{2}$ feet below the full-reservoir level.

Arch Bridge and Retaining Wall near Lower End of Waste Channel.

An arch bridge having a span of 35 feet 6 inches has been constructed across the lower end of the waste channel, affording access to the grounds below the dam from Grove Street on the westerly

HIGHWAY BRIDGE OVER THE WASTE CHANNEL OF THE WACHUSETT RESERVOIR.

side of the pond below the dam. The arch of this bridge is built of Portland cement concrete masonry, faced at the ends with stone. The stone parapet walls and face walls are curved in plan, the radius of the curve midway between the parapet walls being about 275 feet. The total length of the parapet walls, the tops of which are 3 feet 2 inches above the finished roadway, is about 131 feet, and the roadway is 20 feet wide.

Arch Bridge for the Central Massachusetts Railroad.

This bridge, which will have a span of nearly 58 feet, while not included in the original contract for the dam, is to be built by the contractor for the dam under a supplementary agreement. It crosses the waste channel at a considerable angle about 225 feet below the waste-weir. The arch will be built of Portland cement concrete faced at the ends with rubble masonry. Some work has been done preparing foundations, but no masonry has been built.

Amount of Work done and of Materials used.

The following table gives the amount of work done to the end of 1901, the amount of work done during 1902, 1903 and 1904, the total amount of work done to the end of 1904 and the total estimated amount required by the contract: —

	To December 31, 1901.	In 1902.	In 1903.	In 1904.	Total to December 31, 1904.	Total Estimated Amount.
Earth excavation (cubic yards),	43,000	31,900	68,800	59,900	203,600	222,000
Rock excavation (cubic yards),	24,370	12,020	18,800	36,810	92,000	95,000
Rubble stone masonry (cubic yards),	28,486	65,686	69,139	76,598	239,909	252,000
Ashlar masonry (cubic yards),	65	684	2,015	4,905	7,669	8,850
Dimension stone masonry (cubic yards),	-	58	417	830	1,305	2,850
Brick masonry (cubic yards),	-	407	231	398	1,036	1,150
Concrete masonry (cubic yards),	-	5,284	1,906	914	8,104	9,350
Iron and other metal work (tons),	-	582	71	46	699	900

The number of barrels of cement used in the work at the dam has been as follows: —

	To December 31, 1901.	In 1902.	In 1903.	In 1904.	Total to December 31, 1904.
Portland cement,	17,703	21,865	18,719	16,561	74,848
Natural cement,	8,892	52,896	51,533	61,739	175,060
Totals,	26,595	74,761	70,252	78,300	249,908

Of the cement used during 1904, all of the natural cement has been of the Union brand, and 12,421 barrels of the Portland cement have been of the Giant brand, both cements being manufactured by the American Cement Company of Egypt, Pa.; 4,140 barrels of Lehigh Portland cement have also been used.

The amount of cement used in the dam per cubic yard of each class of rubble masonry from the beginning of the work has been as follows: —

Composition of Mortar by Measure.	Barrels of Cement per Cubic Yard.	Cubic Yards built.
1 part natural cement to 1 part sand,	1.43	184
1 part natural cement to 2 parts sand,	0.99	172,251
1 part Portland cement to 2 parts sand,	1.06	31,970
1 part Portland cement to 2½ parts sand,	0.86	8,926
1 part Portland cement to 3 parts sand,	0.79	23,517

The amount of cement used in the dam per cubic yard of each class of concrete masonry has been as follows: —

Composition of Concrete by Measure.	Barrels of Cement per Cubic Yard.	Cubic Yards built.
1 part natural cement, 2 parts sand and 5 parts stone,	1.33	995
1 part natural cement, 3 parts sand and 6 parts stone,	1.15	18
1 part Portland cement, 2½ parts sand and 4½ parts stone,	1.43	5,832
1 part Portland cement, 3 parts sand and 6 parts stone,	1.10	1,087
1 part Portland cement, 4 parts sand and 8 parts stone,	0.70	172

Miscellaneous Notes.

All masonry built before April 12 and toward the latter part of the season — masonry likely to be exposed to the action of the frost — was laid in Portland cement mortar, mixed in the proportion of 3 parts of sand to 1 part of cement. After November 3 all masonry was so laid. The water used for mixing mortar was heated after October 27. Between April 12 and November 3 most of the masonry was laid in natural cement mortar mixed in the proportion of 2 parts of sand to 1 part of cement; but Portland cement mortar

mixed in the same proportions as the natural cement mortar was used, as in previous years, for the masonry in the cut-off trench, for masonry immediately above the ledge rock and in the upper gate-chamber.

The largest amount of rubble masonry laid in the dam during any week was during the week ending June 25, when 11 derricks were in operation, and 3,459 cubic yards were laid. During that week about 42 cubic yards of ashlar masonry were also laid. The average amount of rubble masonry laid per day by each mason has been 13 cubic yards, and by each derrick 56.1 cubic yards. This very large accomplishment has been possible because of the very complete appliances for furnishing materials to the work.

The building of concrete masonry has been entirely in the day-time, and the concrete has been mixed by hand.

A large amount of work has been done grading the grounds below the dam both in the bottom of the valley and on the hillsides. In connection with the construction of the Wachusett Aqueduct and Central Massachusetts Railroad tunnels large quantities of waste rock were dumped on the easterly hillside below the dam, and excavations have been made on the hillside for the dam and for the tracks on which the stone was brought to the dam. These tunnel dumps have been to a large extent removed and graded, the excavations for the tracks and for the dam have been filled, and a large part of the hillside has been covered with soil stripped from the reservoir. In the bottom of the valley the grounds around the pool and the lower gate-chamber have been graded and nearly all covered with soil obtained from the bottom of the old mill-pond. Foundations for the drives and paths below the dam, consisting of about 18 inches in depth of stone from the tunnel dumps, have been placed, and the paths have been finished with a coating of fine screened stone from these dumps.

The stone for the rubble masonry is still obtained from the quarry, about 1½ miles from the dam. The stone for the ashlar and dimension stone masonry has all been obtained from the quarry of H. E. Fletcher & Co., at West Chelmsford, Mass.

The maximum force employed by the contractor, including the men employed at the Chelmsford quarry, was during the week ending July 30, when 778 men and 54 horses were employed. At that time 141 men were employed at the Chelmsford quarry.

Contract 276, Connery & Wentworth.

Superstructure of the lower gate-chamber of the Wachusett Dam; date of contract, March 18, 1904; amount of contract, $72,937.34.

This building covers the gates and other works used for controlling the flow of water to the Wachusett Aqueduct and to the river below the dam, and in it may be installed machinery for generating power. It is 104 feet 6 inches long, 74 feet wide, outside dimensions, and the ridge of the roof is about 59 feet above the ground. A large part of the interior of the building is taken up by one large room, 74 feet 1 inch long by 64 feet wide, the ceiling of which is about 37 feet above the floor. In addition, there are 8 smaller rooms and a large storage room at the easterly end, which will be used for various purposes in connection with the operation of the works.

The exterior walls are of fine pointed granite obtained from the quarry of H. E. Fletcher & Co. at West Chelmsford, Mass.; the interior is finished with red face brick, and the roof is covered with Conosera Spanish roof tiles.

The contractor began to set up a derrick and build an office and storage sheds on May 2, the first stone was set on May 16 and the work on the contract was completed on December 22. The maximum force employed, including the men employed at the Chelmsford quarry, was during the week ending June 18, when 110 men and 7 horses were employed. Seventy-five of these men were employed at the quarry.

The contract price for the superstructure was $72,937.34.

The work under this contract has been performed in a conscientious and workmanlike manner, and the exterior stonework has been particularly well executed.

A Gurney heating plant has been installed, and the building wired for electric lights by employés of the Board.

SOUTH DIKE.

Contract 275, John F. Magee & Co.

Date of contract, December 26, 1903; amount of contract, $139,411.04.

This contract called for soil stripping from about 87 acres of the site of the Wachusett Reservoir, and the construction of the South Dike, except the placing of the heavier riprap. Included in the work is the excavation of a cut-off trench, the refilling of this trench

with compacted soil from the reservoir, the excavation of soil and earth from spoil banks and borrow pits, and the placing of soil and earth in the dike, also the placing of the two lighter grades of rip-rap. The South Dike was fully described in the last annual report.

Work was begun under this contract on January 5, in excavating from the cut-off trench, and on January 7 an additional force was put at work excavating sand and gravel from a borrow pit and hauling same to what formerly was Carville's ice pond, where 2.7 acres of deep muck were covered to a depth of about 1 foot. Work was continued through the winter, in excavating from the cut-off trench and from borrow pits, the material being used for covering the muck and for making the fill of the dike. The winter was an unusually severe one, the snowfall being considerable and the temperature lower than in most winters, making the work difficult. The contract for this work provided that on or before April 1, 1904, the contractor should substantially complete the whole cut-off trench, and should have 200 linear feet of the lowest portion of the trench in readiness for the treatment of the rock. The contractor did not succeed in finishing the 200 feet on the date specified, owing to the severe weather; but the treatment of the rock in the higher part of the trench was commenced on March 31, and this work will be described further on. The amount of material to be handled, and the limited time available for the work, made it necessary that over 45,000 cubic yards of material per month should be handled. This required the provision of a very considerable plant, which was as follows: —

4 locomotives (2 12-ton, 2 16-ton), made by the Vulcan Iron Works, Wilkesbarre, Pa.

1 steam shovel, dipper 2¼ yards capacity, made by John Souther & Co., Boston, Mass.

80 cars for hauling soil, 3¼ cubic yards capacity, made by the Ryan & McDonald Manufacturing Company, Baltimore, Md.

40 cars for hauling gravel, 3 cubic yards capacity, made by the same company as the cars for the soil.

4¼ miles of track.

The contractor also provided 40 cars of 1½ cubic yards capacity, but these cars were not used. In addition, a large number of teams were used.

The principal quantities of work done were as follows: —

Grubbing (acres),	56
Soil excavation (cubic yards),	157,786
Earth excavation (cubic yards),	36,096
Earth excavation from borrow pits (cubic yards),	224,075
Rock excavation (cubic yards),	947
Riprap (cubic yards),	7,687
Paving (cubic yards),	29

The work on this contract was completed on December 8. The maximum force employed was 365 men and 94 horses, for the week ending June 18.

Treatment of Rock in Cut-off Trench.

As before stated, this work was begun on March 31, and was done largely by a day-labor force, though at times the contractor furnished a portion of the men. After the trench was excavated to rock by the contractor, all loose and broken rock was removed by means of bars and wedges. The surface of the rock was then carefully cleaned with brooms, and washed off, by means of a hose, with water under a considerable pressure, a pipe line 3,180 feet long having been laid and connected with the water system of the town of Clinton, to furnish the water. All seams were carefully cleaned out and filled with rich Portland cement mortar, or, if large, with stone laid in mortar. Rubble masonry was built under all overhanging rock which could not be removed with bars and wedges. The entire surface treated was then covered with a thick Portland cement grout, composed of equal parts of cement and fine sand, which was applied by a broom, the surface of the rock being first wet. The total length of cut-off trench treated in this way was 1,884 feet, and the area treated was 42,280 square feet. The bottom of the trench at the lowest point is 50 feet below full-reservoir level. The work was finished May 21.

The maximum force employed was 68 men, for the week ending April 30.

CLINTON SEWERAGE SETTLING BASINS.

Eight settling basins have been added to the Clinton sewerage system. These basins are located immediately south of the filter-beds, alongside and east of the 24-inch vitrified pipe main which conducts sewage to the filter-beds. Each basin has a capacity of

about 237,000 gallons, is about 320 feet long, and has a width at the water line of about 33 feet, the basins being separated from each other by longitudinal banks of soil, which have side slopes of 1½ horizontal to 1 vertical. When the basins are in operation the sewage will have an average depth of about 4 feet below the overflow. The basins are built mostly above the original surface of the ground, the surface soil forming a bottom which allows but little water to pass through. Running under the longitudinal banks which separate the basins are 6-inch vitrified pipe underdrains, the bottoms of which are 2 feet below the bottoms of the basins. These underdrains are intended to intercept any water which may pass through the soil which forms the bottoms and sides of the basins, and convey it to some small filter-beds where it can be refiltered. These small filter-beds have an aggregate area of .83 acres, and the soil removed in preparing them, together with 6 inches of soil from the six beds of the existing system from which the soil was not removed when they were built, was used for constructing the banks which form the basins. Each basin has inlet and outlet structures built of Portland cement concrete, which contain gates for controlling the flow of sewage and for emptying the basins. The basins are so arranged that all or a part of the sewage can be passed through them, or all of it can be delivered as formerly directly to the filter-beds.

The principal quantities of work done were as follows: —

Earth excavation (cubic yards),	11,720
Portland cement concrete 1 : 2½ : 4½ (cubic yards),	148
24-inch vitrified pipe laid (linear feet),	317
18-inch vitrified pipe laid (linear feet),	319
8-inch vitrified pipe laid (linear feet),	1,212
6-inch vitrified pipe laid (linear feet),	2,308

The cost of this work, which was done by a day-labor force between September 1 and November 3, including engineering, was $7,242.13. The maximum force employed was 40 men and 16 horses, for the week ending October 1.

Relocation of Central Massachusetts Railroad.

No contract work has been done on the relocation of the Central Massachusetts Railroad during the year. A day-labor force has graded the approaches to and built an overgrade timber bridge

across the railroad at a farm crossing on the Moran land near West Berlin. The ends of this bridge are supported on masonry abutments, and the timber bents on masonry piers built of Portland cement concrete. A day-labor force has also built two catch-basins, and laid 210 feet of 10-inch Akron pipe to provide drainage for the roadway at the undergrade highway crossing near West Berlin.

The maximum force employed was 34 men and 7 horses, during the week ending June 25.

Roads and Bridges.

When Boylston Street was constructed in a new location, in 1898, a temporary bridge was built over a portion of the Central Massachusetts Railroad, which has since been discontinued. This bridge was removed and a permanent embankment has been built in its place. About 3,100 cubic yards of earth were handled in making the embankment. A culvert, consisting of 120 linear feet of 24-inch cast-iron pipe, was built at this place.

Mortar Experiments.

Mention was made in the last annual report of experiments made to determine the effect of the addition of salt to mortar where not subjected to freezing, the salt being added in the proportion of 4 and 8 pounds per barrel of cement. In this series of experiments 360 briquettes were made, but only part of them had been broken at the time of the last report. All of these briquettes have now been broken, and the results obtained indicate that mortar to which salt has been added in the proportions mentioned is about 20 per cent. stronger than when salt has not been used.

Cement Tests.

The usual tables of tests of cements used in the dam and other works at the Wachusett Reservoir and in the Weston Aqueduct may be found in Appendix No. 2.

WESTON AQUEDUCT DEPARTMENT.

(Horace Ropes, Department Engineer to May 25, when the department was abolished, and the work remaining to be done was placed in charge of Dexter Brackett, Engineer of the Sudbury and Distribution Departments.)

At the end of the year 1903 the Weston Aqueduct and Reservoir were so nearly finished that they had been placed in service. The only contract work remaining to be done was at the Weston Reservoir, where the work was chiefly the spreading of loam over the surfaces of embankments and the completion of the screen-chamber. Along a large part of the aqueduct and around the reservoir there remained the final grading and seeding of embankments, the building of fences and the setting of stone bounds. All of this work has been completed during the year.

The engineering force engaged upon the work numbered 36 at the beginning of the year and 1 at the end of the year. In the early part of the year the force was employed in the preparation of final estimates of the work done under contracts and upon record plans. The principal engineers completed their work as follows: Marshall Nevers, division engineer, April 2; Dan B. Clark, division engineer, April 16; George W. Booth, division engineer, August 9; Walter W. Patch, assistant engineer in charge of records, drafting and computing at the Saxonville office, June 30. George A. Winsor, assistant engineer, has continued on the work throughout the year.

The branch office at Wayland was discontinued on February 29, the Saxonville office on June 30, and the Weston office on July 16.

CONTRACTS.

Nawn & Brock, contractors for Section 14 of the Weston Aqueduct (open channel) and sections 1 and 2 of the Weston Reservoir, resumed the work of grading the embankments near the channel and reservoir on April 9, and completed all the work under their contracts on May 20. It was not feasible, on account of the cold weather in December, 1903, to remove the earth from the surfaces of the rock in the reservoir as thoroughly as was desired, and early in April the water in the reservoir was drawn down about 9 feet, and all rock surfaces to a depth of not less than 6 feet below the full-reservoir level were thoroughly cleaned.

The principal quantities of work performed under these contracts were as follows: —

Clearing and grubbing (acres),	37
Earth excavation (cubic yards),	629,890
Rock excavation (cubic yards),	8,252
Riprap (cubic yards),	3,235
Slope paving (cubic yards),	1,171
Portland cement concrete masonry (cubic yards),	3,537
Ashlar masonry (cubic yards),	46
Dimension stone masonry (cubic yards),	39

The total value of the work done, as shown by the final estimates, was $247,198.07.

The Woodbury & Leighton Company, contractors for the channel and screen-chambers, resumed work on the screen-chamber, and completed it on April 8. The amount of their contract was $12,484.75.

Additional Work on Aqueduct and Reservoir.

Early in the spring the work of building fences, setting stone bounds, grading and seeding the aqueduct embankments and the grounds around the reservoir was resumed, and continued until the latter part of October, when the work was finished. This work was done by day-labor forces, under the direction of Mr. Winsor and the superintendents of the Sudbury and Distribution Departments. It included the building of 86,543 feet of fences, the grading and seeding of 86 acres of land, the setting of about 600 stone bounds, the surfacing of a driveway 1,600 feet long from Newton Street to the screen-chamber at the Weston Reservoir, the excavation of 2,100 linear feet of drainage ditches, the laying of 230 feet of 10-inch Akron pipe at the reservoir, and the construction of a paved channel 735 feet long near the westerly portal of tunnel No. 2, for the purpose of preventing the washing of the slopes by surface water.

Gages for indicating the elevation of the water have been placed in the channel and screen-chambers at the Weston Reservoir, and in the terminal chamber of the aqueduct. Recording gages, one showing the elevation of the water in the aqueduct and one the depth of water on the measuring weir, have been placed in the head chamber near the Sudbury Dam.

Large gates provided with hoisting apparatus have been set in the siphon chambers, and stop-planks have been made for use at other chambers.

Quantity and Cost of Work done in constructing Aqueduct, Reservoir and Supply Pipe Line.

The following tables show the quantities and the cost of the work done in the construction of the aqueduct, reservoir and supply pipe line. It is a summary of the contract work, made from the final estimates, and does not include the work done by the contractors as extra work, or the engineering or the preliminary and additional work done by day-labor forces.

Quantities and Cost of Work done in the Construction of the Weston Aqueduct.

Class of Work.	Quantity.	Cost.	Cost per Unit.
Earth excavation (cubic yards),	659,231	$232,588	$0 35
Borrowed earth (cubic yards),	321,245	79,126	0 24
Overhaul (cubic yards),	380,813	4,396	0 01
Rock excavation (cubic yards),	46,735	76,735	1 64
Tunnel excavation (cubic yards),	66,201	391,162	5 91
Dry filling over arch in tunnel (linear feet),	11,838	9,819	0 83
Tunnel drainage (linear feet),	12,165	3,485	0 29
Brick masonry not in tunnel (cubic yards),	14,210	160,379	11 29
Brick masonry in tunnel (cubic yards),	76	912	12 00
Natural cement concrete masonry not in tunnel (cubic yards),	72,193	286,650	3 97
Portland cement concrete masonry not in tunnel (cubic yards),	57,883	314,120	5 43
Portland cement concrete masonry in tunnel (cubic yards),	22,451	134,575	5 99
Dimension stone masonry (cubic yards),	375	13,805	36 81
Ashlar masonry (cubic yards),	81	1,777	21 94
Face dressing of pointed work (square feet),	7,560	3,599	0 48
Face dressing of six-cut work (square feet),	162	113	0 70
Dry rubble stone masonry and paving (cubic yards),	1,077	3,309	3 07
Riprap (cubic yards),	1,065	2,488	2 34
Lumber (feet B. M.),	107	3,216	30 05
Furnishing and laying 7.5-foot steel pipe (linear feet),	4,756	101,305	21 30
60-inch Venturi meters,	2	7,200	3,600 00
Superstructures,	11	70,384	-
Iron and steel work, including 60-inch and 48-inch pipes between Sudbury Dam and head-house, pipes for culverts, castings for siphon chambers, blow-off pipes for siphons, valves and steel and iron work for connections and chambers, including, generally, the cost of hauling and laying or placing same,	-	70,000	-

Quantities and Cost of Work done in the Construction of the Weston Reservoir, including the Open Channel.

Class of Work.	Quantity.	Cost.	Cost per Unit.
Clearing and grubbing (acres),	37	$3,749	$101 32
Earth excavation (cubic yards),	641,235	198,155	0 31
Earth excavation for drain (cubic yards),	5,369	4,295	0 80
Rock excavation (cubic yards),	5,892	8,124	1 38
Rock excavation for drain and core wall (cubic yards),	2,360	5,900	2 50
Cleaning surface of rock (square yards),	5,162	516	0 10
Portland cement concrete masonry (cubic yards),	3,537	18,345	5 19
Dimension stone masonry (cubic yards),	39	1,194	30 60
Ashlar masonry (cubic yards),	46	830	18 05
Face dressing of pointed work (square feet),	1,036	425	0 41
Slope paving (cubic yards),	1,171	4,684	4 00
Riprap (cubic yards),	3,235	3,235	1 00
Furnishing and laying 18-inch and 20-inch vitrified pipe (linear feet),	296	740	2 50

Quantities and Cost of Work done upon the Supply Pipe Lines from the Weston Aqueduct to Main Pipes near Chestnut Hill Reservoir.

Class of Work.	Quantity.	Cost.	Cost per Unit.
60-inch cast-iron pipe from terminal chamber, Weston Aqueduct, to west bank of Charles River (linear feet),	1,603	$32,643	$20 36
3 lines 60-inch cast-iron pipe under Charles River, laid in coffer-dam and covered with concrete, each line 345 feet long, equivalent to (linear feet),	1,035	43,252	41 79
48-inch cast-iron pipe, Charles River to Chestnut Hill Reservoir, including cost of resurfacing roadways and changing drains and water pipes by city of Newton (linear feet),	36,806	436,617	11 86
Driveway from Loring Street to terminal chamber (linear feet),	1,720	2,098	1 22
Cost of removing rock, and incidentally of removing earth, so that a second pipe could be laid beside the 48-inch cast-iron pipe without blasting,	-	11,679	-
Total,	-	$526,289	-

At the end of the year the Weston Aqueduct and Reservoir had not only been wholly completed, but settlements had been made for contracts, land damages and claims to such an extent that it is feasible to estimate with substantial accuracy that the final cost of the aqueduct, exclusive of the reservoir, will be $2,516,000, equal to $198,000 per mile, and of the reservoir $344,000, making a total

of $2,860,000. The total cost of the supply pipe line from the terminal chamber to a point near Chestnut Hill Reservoir will be substantially $600,000.

The State Board of Health, in its report upon a Metropolitan Water Supply, estimated the cost of the Weston Aqueduct at $3,226,000. This, however, was for an aqueduct having a capacity of 250,000,000 gallons per day, as against a capacity of 300,000,000 gallons per day for the aqueduct actually built, and did not include a reservoir in Weston, which it was thought would not be necessary in the beginning, and might be built at a subsequent date. The only feature included in the State Board of Health estimate and omitted in the construction was one of the two siphon pipes, which will not be required for at least fifteen years.

Taking the works as constructed, without making any allowances, the actual cost has been $366,000 less than the original estimate; and, if an allowance is made for the reservoir which was constructed but not estimated, and for the siphon pipe which was estimated but not constructed, the difference between the actual and estimated cost of the whole work would be $580,000. A further allowance should be made because the aqueduct actually built has one-fifth more capacity than that estimated, but the amount of such an allowance cannot be readily determined.

The cost per running foot or otherwise of different portions of the aqueduct and of the reservoir have been determined, with the following results, which include the cost of construction, engineering and land, the expenses of administration, and all other cost except interest during construction: —

Where the aqueduct is a tunnel, lined with concrete masonry, the cost for the portion which has a width of 10 feet was $39 per foot, equal to $207,000 per mile.

For similar tunnels, which have a width of 13 feet 2 inches, the cost was $69 per foot, equal to $364,000 per mile.

Where the aqueduct was built of masonry in a trench, and covered with earth, the cost for the portion which has a width of 10 feet was $23 per foot, equal to $120,000 per mile.

Where it has a width of 13 feet 2 inches, the cost was $32 per foot, equal to $171,000 per mile.

The two siphons, consisting of one pipe each, with the four siphon chambers, which were built for three pipes each, cover a total length

of 4,841 feet, and the cost was $45 per foot, equal to $237,000 per mile.

The single line of siphon pipe, exclusive of the siphon chambers, covers a total length of 4,726 feet, and the cost with all appurtenances was $36 per foot, equal to $191,000 per mile.

The open channel, 1,366 feet long, which was excavated where the average depth of cutting was 19½ feet, exclusive of the structures at its ends, cost $34 per foot, and exclusive of land damages $25 per foot.

The Weston Reservoir, which cost $344,000, including the screen-chamber at its lower end, serves as a substitute for 4,000 feet of aqueduct, and its cost was $86 per linear foot. As a reservoir its available capacity is about 200,000,000 gallons, making the cost per million gallons $1,720.

DISTRIBUTION DEPARTMENT.

DEXTER BRACKETT, *Department Engineer.*

A considerable part of the time of the department engineer and his assistants has been spent upon the preparation of plans, statistics and estimates in connection with the suit brought by the cities of Malden, Medford and Melrose for damages on account of the taking of Spot Pond. A considerable part of the time of the assistants has also been taken up in making record plans of work done in previous years. There has been no actual work chargeable to construction, except the placing of a Venturi meter.

OFFICE FORCE.

FRANK T. DANIELS, *Principal Office Assistant;* SAMUEL E. KILLAM, *Office Assistant.*

The following is a statement of the more important work upon which the drafting department has been engaged during the year.

For the Wachusett Reservoir, working drawings were made for the Malden Brook culvert and for the false works for the West Boylston arch.

For the Wachusett Dam there have been made general plans and details of the bastion and abutment at the ends of the dam, of the upper gate-chamber, of the highway bridge over the lower end of the waste channel, of several retaining walls, of flights of steps leading from the bottom of the valley up the hillsides to the ends of the dam, plans for grading and drainage about the dam, details of

SCREEN CHAMBER AT OUTLET OF WESTON RESERVOIR.

steel trestles for a foot bridge along the waste-weir, of steelwork for the bastion and upper and lower gate-chambers, of wooden gates and of bronze stop-plank grooves. A direct steam heating plant for the lower gate-chamber was designed, and the necessary drawings for its installation were furnished.

In connection with the relocation of the Central Massachusetts Railroad, detailed drawings were made for a masonry skew-arch railroad bridge over the upper end of the waste channel. The general design for this bridge and for the highway bridge over the waste channel were furnished by Olmsted Brothers, landscape architects. A set of 12 plans, showing in detail the relocated portions of the railroad and tracings of the same, were completed, together with a profile, and sent to the Boston & Maine Railroad.

Other drawings made included drawings for the screening apparatus at the head chamber of the Weston Aqueduct, and a drawing for the extension of the Clinton sewerage works.

The whole number of finished drawings completed during the year is 123. Besides these, various studies and minor drawings were made and a few drawings were changed to adapt them to serve as record plans.

The force employed in the drafting department numbered 7.

Samuel E. Killam has had charge of the general office, where the work is of a varied character, such as making miscellaneous investigations and computations, procuring supplies and making blue prints. Mr. Killam has also had general charge of the photographic work.

Accidents.

Five fatal accidents have occurred during the year, three at the Wachusett Dam, one upon the railroad from the quarry to the dam, and one upon the Wachusett Reservoir.

The first four accidents occurred in connection with the work of the McArthur Brothers Company. At the dam a masonry inspector had the bone of his thigh broken by being caught between a stone which was being raised and the masonry of the dam, and as a result of his injuries died thirteen weeks later; a masonry foreman was killed by the falling of the boom of a derrick; and a laborer by the falling of a large stone which slipped from the grab-hooks. A blacksmith was killed by a collision on the quarry railroad. On Section 8 of the Wachusett Reservoir a laborer was killed by falling under a train on the contractor's railroad.

MAINTENANCE.

(This report upon maintenance has been compiled from reports prepared by the engineers in charge of the various departments of the works.)

The Wachusett Reservoir has been filled during the year to a greater extent than heretofore, and therefore is to a larger extent in the charge of a maintenance force; otherwise the works maintained and operated in 1904 are the same as at the end of the preceding year.

Organization of Maintenance Force.

There has been an important change in the organization of the maintenance force during the year, as already indicated briefly in the beginning of my report. The Sudbury and Cochituate works, which, after the resignation of Desmond FitzGerald, had no department engineer in charge, were on March 10 placed under the charge of Dexter Brackett, who was also at that time given the charge of the maintenance of the Weston Aqueduct.

Charles E. Haberstroh, assistant superintendent of the Sudbury Department, has charge of the maintenance and operation of the works on the Sudbury River and Lake Cochituate, the Cochituate and Sudbury aqueducts and the Weston Aqueduct, from the Sudbury Dam to the Weston Reservoir.

George E. Wilde, assistant superintendent of the Distribution Department, has charge of the maintenance and operation of the Weston Reservoir, of that portion of the Weston Aqueduct between the reservoir and the terminal chamber in Weston, and of all the reservoirs and pipe lines within the Metropolitan District.

John W. Lynch, engineer of the pumping stations, has continued in direct charge of the pumping stations at Chestnut Hill, and has had general supervision of the mechanical work at the other pumping stations of the Distribution Department.

William E. Foss, division engineer, has had special charge of investigations relative to injury of water pipes by electrolytic action.

Caleb M. Saville, division engineer, has continued in charge of the operation of Venturi meters in the Metropolitan District.

Alfred O. Doane, division engineer, has continued in charge of engineering work connected with the maintenance and operation of the pumping stations and pipe lines.

The force employed on maintenance, including the permanent force, the additional temporary forces engaged from time to time on special work, and such of the engineers as devoted most of their time to maintenance, averaged 220. The maximum number employed at any one time was 291.

Rainfall and Yield.

The total rainfall for the year on the Sudbury watershed has been 3.4 inches below the average, the deficiency occurring wholly in the last three months. The yield of the watersheds has been somewhat below the average, but the deficiency occurred at such times that there was no unusual lowering of the reservoirs. Statistics relating to rainfall and yield of watersheds may be found in Appendix No. 3, tables Nos. 1 to 11.

Storage Reservoirs.

The quantity of water stored in all of the storage reservoirs on January 1, 1904, was 13,136,900,000 gallons. On account of the extremely cold weather during the months of January and February the flow of the streams was small, and there was a constant lowering of the reservoirs until February 22, when they reached the lowest point, and contained 10,550,000,000 gallons.

During March the reservoirs filled rapidly, and early in April were as full as it was desirable to hold them until the freshet season was over; subsequently they were filled gradually, reaching the maximum storage of a little more than 26,000,000,000 gallons on June 8.

Until the middle of September there was an almost continual loss of storage, when the heavy rainfall on September 14 and 15 caused a gain of 1,100,000,000 gallons in a period of three days, after which the quantity stored again diminished continuously until December 27. During the last few days of the year there was a slight gain, and at the end of the year the quantity stored was 15,638,100,000 gallons.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

Date.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1904.				
January 1,	1,760,100,000	5,226,600,000	6,150,200,000	13,136,900,000
February 1,	1,374,600,000	4,626,600,000	5,811,800,000	11,813,000,000
March 1,	1,098,500,000	5,195,100,000	5,472,000,000	11,765,600,000
April 1,	8,385,000,000	7,666,900,000	6,898,100,000	22,950,000,000
May 1,	9,863,100,000	8,112,800,000	7,460,500,000	25,436,400,000
June 1,	10,107,500,000	8,380,400,000	7,525,600,000	26,013,500,000
July 1,	9,401,900,000	8,200,900,000	7,540,200,000	25,143,000,000
August 1,	7,885,800,000	8,218,900,000	7,234,900,000	23,339,600,000
September 1,	6,807,300,000	7,951,700,000	6,503,700,000	21,262,700,000
October 1,	6,869,400,000	7,725,500,000	5,975,700,000	20,570,600,000
November 1,	7,192,800,000	6,659,600,000	5,320,000,000	19,172,400,000
December 1,	6,951,500,000	6,419,100,000	4,310,700,000	17,681,300,000
1905.				
January 1,	4,409,600,000	7,912,500,000	3,316,000,000	15,638,100,000

Wachusett Reservoir. — At the beginning of the year work on the Wachusett Reservoir was so far advanced that it was possible to store water to elevation 331.50, which is 47.50 feet above the bottom of the 48-inch cast-iron pipes through the dam. The dam itself was enough higher to permit the water to be safely raised to this height. It was raised nearly to the full height early in April and to the full height in the middle of May, where it was maintained until June 11. When at elevation 331.50 the reservoir contained 10,117,000,000 gallons of water. Most of the time after June 11 water was drawn from this reservoir in sufficient quantities to keep the Sudbury Reservoir nearly full, but for about a month, beginning October 20, the flow was stopped, to permit the Sudbury Reservoir to be drawn down.

At the end of the year the water was 33 feet above the bottom of the 48-inch pipes, and the reservoir contained 4,409,600,000 gallons of water. Between April 26 and 29 there was a rainfall of over 4 inches, which raised the water in the reservoir temporarily to elevation 331.89. At this time the gates which control the flow of water through the four 48-inch pipes which pass through the dam

were fully opened, and the water flowed through at the rate of 1,231,000,000 gallons per 24 hours. Water was wasted into the river below the dam, because of lack of storage capacity, on 43 days between April 9 and June 11, the total amount of waste being about 8,600,000,000 gallons.

Sudbury Reservoir. — At the beginning of the year the water of this reservoir was at elevation 252.63, which is 6.37 feet below the stone crest of the dam. The lowest level during the year was reached on January 28, when the water stood at elevation 249.82. During February and March the reservoir was filling, and on April 4 the water reached the level of the crest of the dam. The reservoir was kept substantially full from that time until October 1. During October and November the water was lowered about 6 feet, in order to facilitate the laying of a water pipe across the reservoir at the Burnett estate in Southborough. On the completion of this work the reservoir was again filled, and on January 1, 1905, the water stood .18 of a foot above the stone crest of the dam.

The driveway from the highway to the Sudbury Dam, which had been badly worn by heavy teaming during the construction of the Weston Aqueduct, has been thoroughly repaired. A wooden building, 58 feet by 22 feet, arranged for a workshop and for the storage of tools and vehicles, has been added to the group of buildings near the Sudbury Dam. The house, barn and shed at the dam, and the house on the Bigelow place, have been painted.

A swampy area on the west side of Maple Street in Marlborough was, at the request of the city authorities of Marlborough, filled to about 12 inches above the ordinary water level. For this purpose 221 cubic yards of material were purchased, and the balance required was obtained by cutting down the higher ground to about the level of the filled area.

The *Marlborough Brook filter-beds* have been in service throughout the year, and have filtered all of the water received from the brook except for parts of six days during freshets. The beds were cleaned during the year, and the dirty sand, including sand from two previous years' cleaning of the artificial beds which had been left at the sides of these beds, was removed to a spoil bank. A layer of clean sand 2½ inches thick was spread on the surface of beds Nos. 1 and 2 and on one-half of bed No. 5. The settling reservoir was also emptied and cleaned.

The analyses which have been made monthly by the State Board of Health of the water before and after passing through the filter-beds show that the water has been generally satisfactorily purified by the filters.

Additional storage for water discharged by the brook during freshets has been provided by the enlargement of storage basin No. 18, increasing its capacity from 2,600,000 gallons to 9,000,000 gallons. The embankments surrounding the basin, 3 feet wide on top, with slopes of 3 horizontal to 1 vertical, were constructed of material excavated from the interior of the basin, and the inner slopes protected with stones taken from the excavation. About 3,300 cubic yards of material were moved in doing this work. The basin is connected by means of a 12-inch cast-iron pipe 210 feet long with the artificial filter-beds Nos. 12 and 17, so that about 8,500,000 gallons can be drawn from the basin to filter-beds Nos. 5, 6, 11, 12, 15 and 17.

The combined storage reservoir and filter-bed for taking care of the overflow from the Marlborough Brook main sewer during times of freshet has taken care of all the overflow during the year. For the greater portion of the time from February 22 until May 7 there was a flow from the sewer to the bed, although for a portion of this time the flow was due to the entrance of ground water into the overflow sewer. After May 7 there was a very small flow of ground water for some time. The largest quantity of diluted sewage stored was on April 30, when it reached elevation 270, which is 3.25 feet below the overflow into an additional storage area.

As the sewage flowing in the open channel from the end of the overflow sewer to the filter-bed gave some offence to the people residing in the house on the opposite side of Farm Road, an 18-inch Akron pipe 212 feet long was substituted for the open channel. A channel was also dug from that part of the bed into which the sewage first enters to the lower bed, so that the upper bed can be drained when desired. An 8-inch tile drain, 385 feet long, was built on the east side of Farm Road, near the toe of the filter-bed embankment, to carry away the water which percolates through the embankment, and the travelled portion of the road was raised about 1 foot for a distance of 300 feet.

Framingham Reservoir No. 3. — This reservoir was kept at or near high-water mark during the whole year.

Framingham Reservoir No. 2. — This reservoir was kept practically full throughout the year. No water was drawn from it for the supply of the Metropolitan District until August 30, but after that date a portion of the supply was drawn from this source almost continually until the end of the year. While water was being drawn from the reservoir the surface was kept near high-water mark by drawing water from the Ashland, Hopkinton and Whitehall reservoirs. On several days between September 14 and 21 water was drawn from the reservoir and discharged into Lake Cochituate.

Framingham Reservoir No. 1. — This reservoir was kept full and water was wasted over the dam from the beginning of the year until September 1. From September 14 to 18, inclusive, and September 21 to 23, inclusive, and on November 29 and 30, water was drawn from the reservoir and discharged into Lake Cochituate.

Repairs have been made to the paving in the channel of the Sudbury River below Framingham Dam No. 1, which had been displaced by the action of the water during freshets. The paving from the dam to a point below the Winter Street bridge has been relaid, and the interstices between the stones filled with fine Portland cement concrete. Below the bridge the paving was not relaid, but concrete was placed between and on the stones, making the bottom of the channel smooth. A large hole in the bed of the river, just below the paving, was partially filled with gravel excavated near by. At the upper end of the reservoir the water overflowing at the dam of Framingham Reservoir No. 3 had gradually excavated a hole which threatened to undermine the original 48-inch pipe-line leading from Framingham Reservoir No. 3 to the dam of Reservoir No. 1. The hole has been partially filled with gravel, and the surface covered with riprap to protect it against washing in the future. There were 1,016 feet of wire fence built on the property line between the land of the Commonwealth and land of Adnah Neyhart.

Ashland Reservoir. — At the beginning of the year the water in this reservoir was 4.33 feet below high water. Early in April the water reached the level of the overflow, and the reservoir remained substantially full until the last of August. During September, October, November and December water was drawn from the reservoir, and on December 27 its surface had been lowered to 192.73, or 32.48 feet below high water. At the end of the year it was 31.34 feet below high water. The joints between the coping stones of the

side-walls of the wasteway at the dam have been cut out and repointed.

Hopkinton Reservoir. — This reservoir was 5.16 feet below high water at the beginning of the year. It was full on May 1, and remained practically full until the first week in September. During the last four months of the year water was drawn from this reservoir, and on December 27 the surface was 32.6 feet below high water. About one-third of the water drawn from the reservoir was filtered. The filter-beds were cleaned in June.

Whitehall Reservoir. — This reservoir has been kept practically full, and was not drawn upon until December 16. From that date until the end of the year 20,000,000 gallons per day were drawn, lowering its surface about 1 foot; and on January 1, 1905, it stood at elevation 336.74, or 1.17 feet below high water.

Farm Pond. — Farm Pond was practically full during the first half of the year, but was then gradually drawn down until the middle of September, when it was 1.25 feet below high water. It was then partially refilled with water drawn from Framingham Reservoirs Nos. 1 and 2. No water was drawn from the pond during the year for the use of the Metropolitan District, and it was not necessary to waste any into the Sudbury River.

Lake Cochituate. — Lake Cochituate at the beginning of the year was 1.94 feet below high water. It fell during January and February, and was 4.56 feet below high water on February 22. It was filled by May 6, and was kept practically full until July 26. The surface then fell steadily until September 14, when the surface was 3.85 feet below high water. Water was then turned into the lake from Framingham Reservoirs Nos. 1 and 2, raising its surface on October 10 to within about 1 foot of high water. The lowest point reached during the year was 5.12 feet below high water, on December 17. Water was wasted at the outlet dam in varying quantities during March, April, May and June. Water was drawn from the lake for the supply of the Metropolitan District from January 1 to April 3, April 6 to 9, April 11 to 17, April 18 to 25, May 3 to 7, July 3 to 7, July 26 to August 2, and August 6 to December 19.

All of the joints in the exterior stonework of the aqueduct gatehouse were cut out and repointed, and two cornice stones which were damaged by fire several years ago were replaced by new stones. A damaged composition stem of one of the aqueduct gates was

replaced by a steel stem furnished by the Coffin Valve Company. The foreman's house was painted two coats, and a trussed wire fence 592 feet long was built along the road near the house.

No water was drawn from Dudley Pond into Lake Cochituate. At the beginning of the year the pond was 3.41 feet below high-water mark. The highest elevation was 155.11, or 1.35 feet below high water, and the elevation at the end of the year was 153.12.

The surface of Dug Pond has varied between 1.5 feet above and 3 feet below the invert of the 18-inch overflow pipe.

The Pegan Brook filter-beds have been in use throughout the year whenever there was water to filter. Water was pumped to the beds during 183 days from the reservoir on Pegan Brook or from the new reservoir at the end of the intercepting ditch which collects water from the brooks formerly draining into Pegan Brook meadow. The total quantity of water pumped during the year was 223,402,500 gallons, of which 150,650,500 gallons was from Pegan Brook and 72,752,000 gallons from the intercepting ditch. The total quantity of coal consumed was 113,941 pounds, so that 1,961 gallons of water were pumped per pound of coal. The cost of operating the pumping station and caring for the filter-beds and grounds was $3,088.16, making the cost per million gallons pumped $13.82.

Sources from which Water has been taken.

An average of 88,554,000 gallons per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. An average of 30,575,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct into the distribution system of the Metropolitan District. From Framingham Reservoir No. 3 an average of 64,827,000 gallons per day, and from Framingham Reservoir No. 2 an average of 9,004,000 gallons per day, was drawn through the Sudbury Aqueduct to Chestnut Hill Reservoir. An average of 14,984,000 gallons per day was drawn from Lake Cochituate through the Cochituate Aqueduct to Chestnut Hill Reservoir. The Spot Pond drainage area furnished 497,000 gallons per day.

Aqueducts.

The *Wachusett Aqueduct* has been in use 283 days during the year. It was very thoroughly cleaned between November 16 and 22. The work of repairing the transverse cracks in the aqueduct, due to

temperature changes, was in progress at the beginning of the year, and was fully described in the last annual report. This work was carried on continuously until January 26, when it was finished. A force of about 26 men, consisting principally of masons who had been engaged during the warmer weather on the construction of the Wachusett Dam, was employed. The usual work of maintenance along the line of the aqueduct has been performed, and the aqueduct and its appurtenances are in excellent condition.

The *Sudbury Aqueduct* was emptied for cleaning on May 5 and 6, and again on May 12 and 13. On June 23 it was emptied for the purpose of examining the Waban Bridge, and from September 14 to 18, from September 21 to 23, from October 2 to 9, and from October 23 to 30, it was emptied for the purpose of making repairs to and lining the aqueduct on the Waban Bridge. At times while the aqueduct was emptied for cleaning and for making repairs at the Waban Bridge, and also on November 29 and 30, water was run from Framingham Reservoirs, Nos. 1, 2 and 3 through the aqueduct to Lake Cochituate. The total amount diverted to the lake was 1,157,200,000 gallons, of which 963,200,000 gallons was drawn from Framingham Reservoir No. 1, 118,300,000 gallons from Framingham Reservoir No. 2, and 75,700,000 gallons from Framingham Reservoir No. 3. The daily average flow through the aqueduct to Chestnut Hill Reservoir for the year was 73,831,000 gallons, which is 24,190,000 gallons less than the corresponding quantity for the preceding year.

The leakage from the aqueduct at the Waban Bridge, due to cracks in the masonry, had increased during the past few years to such an extent as to cause a large loss of water, as well as to injure the masonry of the bridge by freezing during the winter. Upon examination, the principal cracks were found to be in the invert two feet from the centre of the aqueduct. They were sometimes on only one side of the centre, but generally on both, and were directly over the joints between stones which cover drainage galleries beneath the aqueduct. As there were few if any cracks above the springing line of the upper arch up to the highest point reached by the water when the aqueduct is in use, the repairs which were made extended only from the bottom up to the springing line. This portion of the aqueduct for the entire length of the bridge, a distance of 562.25 feet, was lined with sheet lead weighing 3½ pounds per square foot,

covered on the bottom with a protective layer of Portland cement concrete $1\frac{1}{2}$ inches thick. The lead is held in place at the springing line by $2\frac{1}{2}$ by $2\frac{1}{2}$ inch angle irons, secured by $\frac{9}{16}$ inch diameter yellow metal bolts set in the masonry. Rubber tubing was placed back of the angle irons between the sheet lead and the masonry, to act as a washer to prevent leakage. The sheets of lead 9 by 14 feet were connected by the process of lead burning so as to form a continuous sheet. The layer of Portland cement concrete $1\frac{1}{2}$ inches thick was composed of fine material, in which was embedded expanded metal. Before the aqueduct was lined all cracks were pointed or grouted, and two coats of Portland cement wash were applied to the arch. All cracks in the aqueduct for 50 feet from both ends of the lining were cut out and pointed. The work has resulted in reducing the leakage to a very small quantity, which it is thought will cause no damage.

While the work at the Waban Bridge was in progress, all the cracks in the interior masonry at the Echo Bridge over the Charles River were cut out and pointed.

In September changes were made in the Beaver Dam Brook culvert, for the purpose of increasing its capacity. The work done consisted in the removal of portions of the masonry so as to enlarge the channels at the entrance and outlet, and in rounding the corners of other portions of the masonry so as to reduce losses of head. As the culvert is below the level of the water in the brook, it was necessary to operate a centrifugal pump while the work was in progress, to take care of the water.

The joints in the masonry of 14 culverts between Waban Bridge and the west siphon chamber have been cut out and repointed. The iron gratings and beams in the siphon and waste-weir chambers, and the manhole covers, have been given two coats of paint, and the iron and wooden fences at both the Echo and Waban bridges have been given one coat. There were 1,575 feet of board fence built near the Course Brook waste-weir, and 250 feet at Harrison Street in Newton Highlands; 440 feet of trussed wire fence were built in South Framingham, and posts set for 1,400 feet just east of Speen Street near the Course Brook waste-weir.

An apparatus for rating current meters has been established at the side of the aqueduct embankment near the Farm Pond gate-house.

During the year the city of Newton built a 48 by 53 inch brick

sewer under the aqueduct, about 500 feet east of Woodward Street. The invert of the sewer was 27 feet below the invert of the aqueduct, and the material underlying the aqueduct was very fine sand. In order to avoid any injury to the aqueduct, compressed air was used in excavating a tunnel under the aqueduct in which to build the sewer, and the work was successfully accomplished.

The *Cochituate Aqueduct* was in use 259 days. The interior of the aqueduct, with the exception of the siphon pipes, was cleaned on April 28 to 30. The surveys for locating the aqueduct and determining the position of property bounds have been continued, and 51 alignment bounds and 52 property bounds have been set.

The *Weston Aqueduct* was in use 320 days. The flow was shut off for about three weeks in April, in order to give opportunity for completing the Weston Reservoir. At this time several cracks in the aqueduct masonry on sections 10 and 15 were cut out and pointed, and the brick masonry on Section 15 was given a coat of cement wash. From June 16 to 20 the aqueduct was shut off while the concrete bottom and sidewalls of the terminal chamber were plastered for the purpose of preventing leakage. During the last two weeks of the year the aqueduct was emptied for the purpose of cutting out and pointing the fine transverse cracks in the concrete masonry, caused by temperature changes. A force of 30 masons and 10 laborers was engaged on this work, which will be continued for a month or more during the coming year. The methods employed for this work are the same as for similar work at the Wachusett Aqueduct, described on page 151 of the last annual report.

Pumping Stations.

Seventy-four per cent. of all the water supplied to the Metropolitan Water District has been pumped at the two stations at Chestnut Hill Reservoir; the remainder was delivered by gravity.

The total quantity pumped at all of the stations during the year was 34,962,090,000 gallons, or 6,854,110,000 gallons less than during the preceding year. The cost of operating the stations was $91,411.63, equivalent to $2.615 per million gallons pumped. Although the average height to which the water was pumped in 1904 was 86.87 feet, as against 68.50 feet in 1903, there has been a decrease in the cost per million gallons pumped of $0.195, due to a reduction in the cost of repairs and fuel.

The cost per gross ton of fuel used at the Chestnut Hill high-service station was $1.41 less, at the Chestnut Hill low-service station $1.43 less, and at the Spot Pond station $0.92 less, than during the preceding year. This reduction was due both to the reduced price of coal and to the use of a larger proportion of anthracite buckwheat coal and screenings.

Notwithstanding the use of a larger proportion of the cheaper grades of fuel, the duty developed by the engines at the Chestnut Hill and Spot Pond stations was between 3 and 4 per cent. greater than during the preceding year.

Tests have been made to determine the viscosity, specific gravity and burning point of all oil, and the calorific value of all coal used at the several stations.

Coal for use at the several stations has been purchased as follows: —

	Gross Tons.					Price per Gross Ton.
	Chestnut Hill High-service Station.	Chestnut Hill Low-service Station.	Spot Pond Station.	West Roxbury Station.	Arlington Station.	
Bay State Fuel Company, bituminous, .	37.17	56.01	-	-	-	$5 36
Dartmouth Coal Company, bituminous,	30.87	-	-	-	-	4 79
Dartmouth Coal Company, bituminous,	-	181.90	-	-	-	4 56
Henry T. Woods, bituminous, . .	671.56	-	-	-	-	4 49
Henry T. Woods, bituminous, . .	-	820.07	-	-	-	4 46
Darrow-Mann Company, bituminous, .	919.93	720.36	-	-	-	4 35
Murrell Coal Company, bituminous, .	332.31	-	-	-	-	4 18
Dartmouth Coal Company, bituminous,	1,031.25	521.11	-	-	-	4 15
Darrow-Mann Company, bituminous, .	-	106.42	-	-	-	4 02
Dartmouth Coal Company, bituminous,	-	102.39	-	-	-	3 98
E. B. Townsend, buckwheat anthracite,	493.08	-	-	-	-	3 28
E. B. Townsend, buckwheat anthracite,	-	998.87	-	-	-	3 08
E. B. Townsend, screenings, . . .	-	10.15	-	-	-	3 67
E. B. Townsend, screenings, . . .	20.54	-	-	-	-	3 44
E. B. Townsend, screenings, . . .	-	77.30	-	-	-	3 18
Gillespie & Pierce, screenings, . .	161.63	2.49	-	-	-	2 24
Bay State Fuel Company, screenings, .	479.50	-	-	-	-	2 24
Locke Coal Company, bituminous, .	-	-	700.00	-	-	4 40
Locke Coal Company, screenings, . .	-	-	414.68	-	-	2 24
D. J. Cutter & Co., anthracite, . .	-	-	-	285.58	-	$7 28 and 7 56
Peirce & Winn Company, bituminous, .	-	-	-	-	346.30	4 48 to 5 04
Wellington Wild Coal Company, bituminous.	-	-	-	-	22.43	4 76
Peirce & Winn Company, screenings, .	-	-	-	-	151.64	2 24
Total gross tons, bituminous, . .	3,023.09	2,508.26	700.00	-	368.73	-
Total gross tons, anthracite, . .	493.08*	998.87*	-	285.58	-	-
Total gross tons, anthracite screenings.	661.67	89.94	414.68	-	151.64	-
Average price per gross ton, bituminous.	$4 31	$4 35	$4 40	-	$4 68	-
Average price per gross ton, anthracite.	3 28*	3 08*	-	$7 36	-	-
Average price per gross ton, anthracite screenings.	2 28	3 21	2 24	-	2 24	-

* Buckwheat.

Chestnut Hill High-service Station.

The water used in the high-service district of Boston, in the city of Quincy and the towns of Watertown, Belmont and Milton, was pumped at this station.

The following are the statistics relating to the operations at this station: —

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals for Station.
Total quantity pumped (million gallons),	576.20	292.86	10,522.75	11,391.81
Daily average quantity pumped (gallons),	1,574,000	800,000	28,751,000	31,125,000
Total coal used (pounds),	1,012,902	279,676	8,656,737	9,949,315
Gallons pumped per pound of coal,	568.12	1,047.14	1,215.56	1,144.96
Average head pumped against (feet),	120.69	127.90	129.30	128.83
Cost of pumping: —				
Labor,	$1,908 35	$473 27	$12,885 18	$15,266 80
Fuel,	1,866 74	471 12	15,113 17	17,451 03
Repairs,	149 64	344 10	516 16	1,009 90
Oil, waste and packing,	64 52	16 00	438 64	519 16
Small supplies,	142 09	22 03	614 26	778 38
Totals,	$4,131 34	$1,326 52	$29,567 41	$35,025 27
Cost per million gallons pumped,	$7.170	$4.529	$2.810	$3.075
Cost per million gallons raised 1 foot high,	.059	.035	.022	.024

The quantity pumped was nearly 4 per cent. greater, and the cost per million gallons pumped was $1.704 less, than during the previous year. The greater part of the reduction in the cost of pumping was due to decreased cost of fuel and repairs.

Chestnut Hill Low-service Station.

The quantity of water pumped at this station was 27.8 per cent. less than during the year 1903, the reduction being due to the use of the Weston Aqueduct.

The following are the statistics relating to operations at this station: —

	Engines Nos. 5, 6 and 7.
Total quantity pumped (million gallons),	20,268.94
Daily average quantity pumped (gallons),	55,380,000
Total coal used (pounds),	8,662,868
Gallons pumped per pound of coal,	2,339.75
Average head pumped against (feet),	54.91

Cost of pumping: —	Engines Nos. 5, 6 and 7.
Labor,	$15,593 00
Fuel,	15,720 63
Repairs,	1,190 77
Oil, waste and packing,	522 54
Small supplies,	837 21
Total for station,	$33,864 15
Cost per million gallons pumped,	$1.671
Cost per million gallons raised 1 foot high,	.030

The cost per million gallons pumped was $0.176 more than for the year 1903. This was due to the decrease in the quantity pumped, and to an increase of 17 feet in the average head pumped against.

Spot Pond Pumping Station.

The 20,000,000-gallon Holly engine pumped all the water at this station.

The following are the statistics relating to operations at this station: —

	Engine No. 9.
Total quantity pumped (million gallons),	2,927.47
Daily average quantity pumped (gallons),	7,999,000
Total coal used (pounds),	2,462,802
Gallons pumped per pound of coal,	1,188.67
Average head pumped against (feet),	129.33
Cost of pumping: —	
Labor,	$7,070 49
Fuel,	3,990 00
Repairs,	183 55
Oil, waste and packing,	158 40
Small supplies,	466 35
Total for station,	$11,868 79
Cost per million gallons pumped,	$4.054
Cost per million gallons raised 1 foot high,	.031

The cost per million gallons pumped was $0.52 less than during the previous year, due to the reduction in the cost of fuel, and the use during the entire year of the more economical engine.

West Roxbury Pumping Station.

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station: —

Pumps operated 6,558 hours; average, 18 hours per day.

Daily average quantity of water pumped (gallons),	504,000
Daily average quantity of coal consumed (pounds),	1,683
Gallons pumped per pound of coal,	300
Average lift in feet,	133
Cost of pumping: —	
Labor,	$2,960 14
Fuel,	2,054 34
Repairs and small supplies,	298 03
Total for station,	$5,312 51
Cost per million gallons pumped,	$28.799
Cost per million gallons raised 1 foot high,	.217

The quantity pumped was 82,000 gallons per day, or nearly 20 per cent. greater than during the year 1903, while the cost of operating remained nearly the same. The cost per million gallons pumped was $5.55 less than for the previous year.

Arlington Pumping Station.

All water supplied to the town of Lexington and to the high-service district of Arlington was pumped at this station.

The following are the statistics relating to operations at this station: —

Pumps operated 8,771 hours 30 minutes; average, 24 hours per day.

Daily average quantity of water pumped (gallons),	517,000
Daily average quantity of coal consumed (pounds),	3,000
Gallons pumped per pound of coal,	173
Average lift in feet,	282
Cost of pumping: —	
Labor,	$3,089 58
Fuel,	1,989 03
Repairs and small supplies,	262 30
Total for station,	$5,340 91
Cost per million gallons pumped,	$28.199
Cost per million gallons raised 1 foot high,	.100

The cost per million gallons pumped was $3.766 less than during the year 1903, due to a reduction in the cost of fuel.

The exterior of the building has been painted.

Consumption of Water.

The daily average quantity of water consumed in the cities and towns supplied by the Metropolitan Water Works during the year 1904 was 114,876,000 gallons, equal to 123.8 gallons per inhabitant in the district supplied. In addition to the above, 631,540,000 gallons, equivalent to a daily average supply of 1,726,000 gallons, were supplied to the city of Cambridge.

The consumption in the several districts was as follows: —

	Gallons per Day.	Increase (Gallons per Day).
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston,	47,652,000	3,924,000
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston,	27,630,000	2,192,000
Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, Belmont, and a portion of Milton,	30,610,000	1,083,000
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston,	7,963,000	434,000
Southern extra high-service district, embracing the highest portions of West Roxbury and Milton,	504,000	82,000
Northern extra high-service district, embracing Lexington and the highest portions of Arlington,	517,000	13,000
Totals,	114,876,000	7,728,000

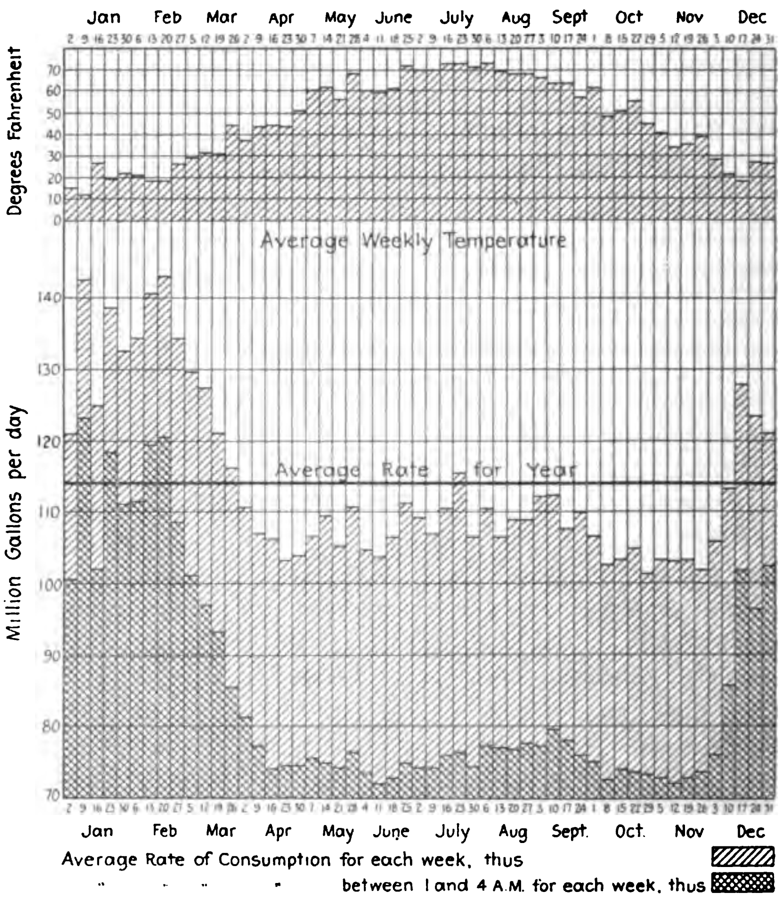
In June a portion of the Dorchester district of the city of Boston, containing about 9,000 people, was transferred from the southern low-service to the southern high-service district. With this exception the area of the several districts remains substantially the same as in 1903.

The increase of 7,728,000 gallons per day in the consumption during the past year was due to a great extent to the use of water to prevent freezing of service pipes during the unusually cold weather in January, February, March and December. In February the daily average quantity used was 139,941,000 gallons, which was 20,318,000 gallons in excess of the quantity used in February, 1903; and the daily average for the months of January, February, March and December was 13,445,000 gallons more than during the corresponding months of the previous year, while the increase for the remaining eight months of the year was 4,886,000 gallons per day.

During the past year continuous measurements have been made by means of Venturi meters of the water consumed in each city and town supplied from the Metropolitan Works. From these measurements can be determined the consumption of water at any hour of the day in any city or town; and in cases where the city or town is divided into low and high service districts, the rate of consumption in each of these districts can also be determined.

The following diagram shows the daily average rate of consumption of water in the district supplied by the Metropolitan Works for

Average Rate of Consumption in Metropolitan Water District and Average Temperature of Air at Chestnut Hill Reservoir for Each Week during 1904.



each week during the year, also the rate of consumption between the hours of 1 and 4 A.M., and the average temperature of the air for the week. It will be noticed that the largest consumption of water occurred during the weeks when the temperature was lowest, and that the rate of consumption between the hours of 1 and 4 A.M. for several weeks in January and February was larger than the 24-hour rate during the summer months.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the year 1904, as measured by the Venturi meters, was as follows: —

	Estimated Population.	Daily Average Consumption.	
		Gallons.	Gallons per Capita.
Boston,	611,830	87,680,800	143
Somerville,	70,320	6,228,300	89
Malden,	40,825	1,868,000	46
Chelsea,	37,835	4,260,500	113
Everett,	29,370	2,624,400	89
Quincy,	27,830	2,828,200	101
Medford,	22,125	1,802,900	81
Melrose,	14,445	1,525,100	106
Revere,	13,710	933,000	68
Watertown,	11,250	623,600	55
Arlington,	10,150	752,400	74
Milton,	7,740	316,300	41
Winthrop,	7,770	742,300	96
Stoneham,	6,420	558,300	87
Belmont,	5,045	248,800	49
Lexington,	3,620	282,700	78
Nahant,	2,310	131,000	57
Swampscott,	6,170	521,200	84
District,	928,770	113,922,300	123

A comparison of the figures in this table shows very plainly the great difference in the quantity of water consumed in different municipalities, and is of especial interest at the present time, for the reason that, in compliance with chapter 426 of the Acts of the year 1904, the measurements of the water used by each municipality

during the year 1905 will be used in determining the assessment to be paid by each in 1906. Similar figures for each month of the year are given in Appendix No. 3, Table No. 22.

The autographic records furnished by the Venturi meters are frequently of much assistance in detecting leaks from the pipes, and in determining the quantity of water used at large fires or for other purposes in excess of the ordinary consumption. A study of these records from week to week also furnishes much information of value in determining the causes of and in preventing the waste of water. For example, the Venturi meter supplying the town of Swampscott indicated, on February 14, an increase in the consumption from 400,000 gallons to about 1,000,000 gallons per day. The local authorities were notified on February 16 that there was probably a large leak from their pipes, but it was not until February 26 that the cause was discovered and the leak repaired. Had it not been for the record of the meter, this leak, which was due to a broken 8-inch pipe, would probably have continued for a long time, as it ran into a drain without showing on the surface of the ground.

The consumption of water in the cities and towns supplied from the Metropolitan Works, as measured by the Venturi meters, is slightly less than the quantity supplied to the District, as determined by pump measurements, and by the flow of the Weston Aqueduct as measured by a Venturi meter. The total difference is less than 1,000,000 gallons per day, a large part of which is accounted for by the quantity of water used at the pumping stations, and by the leakage from the 84.21 miles of pipes and the several distributing reservoirs connected with the works, this use and leakage not being measured by the Venturi meters.

Quality of the Water.

Samples of water were collected every three months from four points, every two months from six points, and monthly from seven points on the works, and sent to the State Board of Health for analysis and examination. Samples of water were also collected each week from many points upon the works, and examined microscopically and for color, odor, taste and turbidity by the biological force of the Metropolitan Water and Sewerage Board.

The quality of the water furnished was substantially the same as during the past two years.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1900 to 1904, inclusive: —

	1900.	1901.	1902.	1903.	1904.
State Board of Health Examinations.					
Color (Nessler standard),	0.24	0.24	0.26	0.25	0.23
Total residue,	3.80	4.43	3.93	3.98	3.93
Loss on ignition,	1.20	1.64	1.56	1.50	1.59
Free ammonia,	0.0012	0.0013	0.0016	0.0013	0.0028
Albuminoid ammonia, total,	0.0157	0.0158	0.0139	0.0125	0.0139
Albuminoid ammonia, dissolved,	0.0138	0.0143	0.0119	0.0110	0.0121
Albuminoid ammonia, suspended,	0.0019	0.0015	0.0020	0.0015	0.0018
Chlorine,	0.25	0.30	0.29	0.30	0.34
Nitrogen as nitrates,	0.0076	0.0173	0.0092	0.0142	0.0110
Nitrogen as nitrites,	0.0001	0.0001	0.0001	0.0001	0.0001
Oxygen consumed,	0.38	0.42	0.40	0.39	0.37
Hardness,	1.8	1.7	1.3	1.5	1.5
Metropolitan Water and Sewerage Board Examinations.					
Color (platinum standard),	34	34	33	35	32
Turbidity,	-	2.0	2.3	2.2	2.4
Total organisms,	468	243	367	286	303
Amorphous matter,	97	38	34	36	36
Bacteria,	181	162	164	126	176

NOTE. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

More than 8 per cent. of the water supplied to the Metropolitan District passes through Spot Pond, in which the color is reduced by the bleaching action due to long storage to about two-thirds that of the water supplied to the remainder of the District.

BIOLOGICAL LABORATORY.

The laboratory has been in charge of Burton G. Philbrick, biologist.

The samples of water have been taken weekly at twenty-nine points and fortnightly at six points on the works, and special samples have been taken from time to time from the reservoirs and the brooks entering them, and from the filters at Marlborough, Hopkinton and Lake Cochituate. There were made during the year 2,277 microscopical examinations, of which 1,756 were made in connection with the regular weekly samples, and 521 in connection with the miscellaneous samples.

The Wachusett Reservoir has had water stored in it for the whole year for the first time, and the water in it now has the characteristics of a reservoir rather than a river water, in that it contains a

somewhat larger growth of microscopic organisms, and is to some extent decolorized by storage. The organisms have not been abundant, and the water has been practically free from odor. The color during the latter part of the season was much lower than that of the river water.

In the Sudbury Reservoir and in Framingham Reservoir No. 3 the microscopic organisms were more abundant in the latter half of the year than usual, causing an odor which was quite persistent, and which was reported from week to week by the biologist. The odor did not, however, become sufficiently strong to cause complaints from the water takers.

In Lake Cochituate the organisms were unusually few for nearly the whole of the year, and the water of such satisfactory quality that it could be used during the greater part of the year. In December, however, there was an abundant growth of Synura, which rendered the water for the time being unsuitable for use.

The bacteriological work for the year consisted of routine weekly examinations, monthly examinations of the main feeders of the Sudbury Reservoir, of Framingham Reservoir No. 3 and of Lake Cochituate, monthly tests of the efficiency of the Pegan and Marlborough Brook filters, and occasional miscellaneous examinations. A total of 530 samples were examined.

Sanitary Inspection.

The sanitary inspection of the Wachusett, Sudbury and Cochituate watersheds has been continued during the year, under the direction of William W. Locke, C.E., Sanitary Inspector.

Upon the Wachusett watershed there have been 10 cases of typhoid fever in Holden, 3 in Princeton and 1 in West Boylston. None of these cases were within the limits of the reservoir. The usual close watch has been kept over the camps and laborers employed within the limits of the reservoir, to see that the water supply was not polluted. The number of cases of typhoid fever upon the Sudbury and Cochituate watersheds was 20, divided as follows: Marlborough, 6; Framingham, 6; Westborough, 6; Southborough, 1; and Wayland, 1.

A summary of the work of sanitary inspection for 1904 is given in the following four tables. The first table shows for the Wachusett watershed the number of premises inspected, the classification

of cases inspected, and the condition of the premises at the end of the year; the second table gives the corresponding information for the Sudbury and Cochituate watersheds; the third table shows the improvements effected on the Wachusett watershed; and the fourth table the improvements effected on the Sudbury and Cochituate watersheds.

The headings of these tables explain themselves, except in a few instances: under the heading "Premises Vacant" are included all cases which at present furnish no objectionable drainage, but which might furnish such drainage if the premises were occupied; under the heading "Unsatisfactory" are included all cases where there may be, under the most unfavorable conditions, wash from privies or direct sink drainage, all suspected cases, and all cases of manufacturing wastes entering feeders, even though there may be some attempt at previous purification.

In the third and fourth tables no cases are entered as remedied unless complete sewer connections have been made, or all probability of future contamination has been removed; and no cases are entered as partly remedied except where positive improvement in the sanitary condition has been effected.

Summary of Sanitary Inspections on the Wachusett Watershed in 1904.

District.	Number of Premises Inspected.*	Classification of Cases inspected.									Condition at End of Year.	
		Cesspools dug before 1904.	Cesspools dug in 1904.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
French Brook,	88	36	-	-	-	2	6	34	-	6	79	9
Muddy Brook,	32	11	-	-	-	-	4	20	-	2	30	2
Gates Brook,	138	73	3	-	-	2	9	60	-	3	132	6
Malden Brook,	16	8	-	-	-	-	1	13	-	-	15	1
Chaffin Brook,	146	34	1	-	4	6	31	78	1	4	130	16
Asnebumskit Brook,	270	110	11	2	4	27	26	110	3	12	232	38
Musquapoag,	101	22	-	-	4	-	18	58	1	12	89	12
South Wachusett Brook,	90	17	1	-	5	1	7	43	-	8	83	7
Trout Brook,	49	4	1	-	2	-	4	28	1	1	47	2
East Wachusett Brock,	212	47	1	1	7	5	25	112	-	13	198	14
Stillwater River,	170	63	8	-	4	5	17	74	-	7	163	7
Waushacum,	180	53	3	3	6	19	19	67	-	5	152	28
French Hill,	38	17	1	-	-	1	3	14	-	3	36	2
Totals,	1,530	495	25†	6	36	68	170	711	6	76	1,386	144

* On some premises there are two or more cases.

† In addition, ten cesspools and six privy vaults for temporary use were built at houses owned by the Board, which have been or will be ultimately torn down.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1904.

District.	Number of Premises inspected.*	Classification of Cases inspected.									Condition at End of Year.	
		Cesspools dug before 1904.	Cesspools dug in 1904.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
Sudbury Watershed.												
Farm Pond,	3	2	-	-	-	-	-	1	-	-	3	-
Framingham Reservoir No. 3,	7	5	-	-	-	-	2	-	-	-	5	2
Stony Brook,	55	41	3	-	-	1	3	8	-	4	51	4
Angle Brook,	304	168	4	-	2	19	47	30	3	18	244	60
Framingham reservoirs Nos. 1 and 2, and Cold Spring Brook.	26	17	4	-	-	-	6	2	-	1	21	5
Eastern Sudbury,	37	23	3	-	-	-	1	2	-	9	35	2
Indian Brook,	47	20	1	-	-	4	14	3	-	5	30	17
Western Sudbury,	22	14	-	-	1	1	4	4	1	5	16	6
Whitehall Reservoir,	5	3	-	-	-	-	1	2	-	-	5	-
Cedar Swamp,	54	30	2	-	-	-	4	3	1	5	49	5
Cochituate Watershed.												
Snake Brook,	37	23	6	-	-	1	9	4	-	-	28	9
Pegan Brook,	93	39	1	-	1	3	9	12	3	4	82	11
Course Brook,	6	4	-	-	-	-	1	1	-	1	5	1
Beaver Dam Brook,	116	47	1	-	-	4	12	11	4	7	103	13
Dug Pond,	35	5	-	-	-	3	7	-	-	-	25	10
Totals,	847	441	25	-	4	36	120	83	12	59	702	145

* Not including a large number of premises which were found on examination to be in a satisfactory sanitary condition, and likely to remain so. On some premises there are two or more cases.

Sanitary Improvements effected on the Wachusett Watershed in 1904.

District.	Remedied by Filter-bed.	Otherwise remedied.	Partly remedied.
French Brook,	-	-	-
Muddy Brook,	-	-	-
Gates Brook,	-	-	4
Malden Brook,	-	2	-
Chaffin Brook,	-	3	-
Asnebumskit Brook,	-	2	5
Musquapoag,	-	-	-
South Wachusett Brook,	-	-	1
Trout Brook,	-	1	3
East Wachusett Brook,	1	2	2
Stillwater River,	-	2	-
Waushacum,	-	2	1
French Hill,	-	-	1
Totals,	1	14*	17

* One schoolhouse in Princeton removed to a safe location.

Sanitary Improvements effected on the Sudbury and Cochituate Watersheds in 1904.

District.	Remedied by Sewer Connection.	Otherwise remedied.	Partly remedied.	Cesspools abandoned on Account of Sewer Connections.
Sudbury Watershed.				
Farm Pond,	-	-	-	-
Framingham Reservoir No. 3,	-	-	-	-
Stony Brook,	-	-	3	-
Angle Brook,	35	1	4	33
Framingham reservoirs Nos. 1 and 2, and Cold Spring Brook.	-	-	4	-
Eastern Sudbury,	-	1	3	-
Indian Brook,	-	-	1	-
Western Sudbury,	-	-	-	-
Whitehall Reservoir,	-	-	-	-
Cedar Swamp,	13	2	2	13
Cochituate Watershed.				
Snake Brook,	-	-	6	-
Pegan Brook,	36	-	1	35
Course Brook,	-	-	-	-
Beaver Dam Brook,	45	-	1	44
Dug Pond,	15	-	-	15
Totals,	144	4	25	140

Among the cesspools dug on the Wachusett watershed during the year were two, each 10 feet in diameter and 10 feet deep, for large private sanatoriums in Rutland. As the soil was poor for filtration purposes, about 450 feet of 4-inch open-jointed tile pipe were laid near the surface from each cesspool, to receive the overflow.

The work of making sewer connections in the various towns has not on the whole progressed quite as rapidly as during the preceding year.

In Natick fixtures were installed and sewer connections made with 51 houses, against 75 the preceding year.

In South Framingham 45 houses have been connected with the sewer, against 56 the preceding year.

In Marlborough there have been 35 connections, against 23 the preceding year.

In Westborough 13 connections have been made, against 10 the preceding year, — a total of 144 against 164 the preceding year.

The sanitary conditions at Hopkinton still remain somewhat unsatisfactory.

The New York, New Haven & Hartford Railroad Company has double-tracked its road from Framingham to Southborough this year, and, as the road for a portion of the distance crosses two of the reservoirs, special inspection has been necessary, to prevent the pollution of the water by the workmen.

There are in places leaks into the Cochituate Aqueduct, where it is built in deep cuttings or in tunnel. By collecting samples of water from these leaks, and analyzing them, evidence was found of pollution which was traced to two houses in Newton. Temporary measures were taken to stop the pollution, and later in the year the city of Newton extended its sewerage system, and these houses were connected with it.

A new sanitary census of the Sudbury and Cochituate watersheds was begun this year, similar to that taken in 1902 on the Wachusett watershed. This has been completed for the whole town of Southborough and portions of Natick and Ashland, and it is expected that it will be completed for the remainder of these watersheds in 1905.

Drainage of Swamps.

The ditches built to drain swamps on the Sudbury and Wachusett watersheds, having a total length of 27.4 miles, have required no special repairs during the year. The 15.55 miles of ditches tributary to the open channel require about two-thirds of the time of 2 men to maintain them in good condition. Special forces are also required at times to cut the bushes at the sides of the ditches.

Observations of the color of water from Crane swamp and from the swamp southwest of Marlborough Junction before and after draining have been given in previous reports. For the year 1904 the average colors have been respectively 99 and 71, which are somewhat lower than in most previous years.

Distributing Reservoirs.

The distributing reservoirs maintained by the Board are the Weston and Chestnut Hill reservoirs; the Waban Hill and Forbes Hill reservoirs and the Forbes Hill standpipe, of the southern high-service system; Spot Pond and the Mystic Reservoir, near Tufts

College, of the low-service system; the Fells and Bear Hill reservoirs, of the northern high-service system; and the Arlington standpipe, of the northern extra high-service system.

Weston Reservoir.

Since the completion of the Weston Reservoir, in the spring, the grounds about it have been kept in good order, the grass has been cut and the hay harvested.

Chestnut Hill Reservoir.

In addition to the usual care of the gate-houses and grounds, repairs have been made at this reservoir as follows: the cover stones over the Cochituate Aqueduct, near the influent gate-house, have been reset, and the joints between the flagstones surrounding the influent and intermediate gate-houses have been repointed. At the old effluent gate-house the masonry of the steps was repointed. Three manholes on the surface water drain near the Lawrence Basin have been rebuilt. The ironwork in the terminal chamber of the Sudbury Aqueduct and in the small gate-house on the Cochituate Aqueduct near the high-service pumping station was cleaned and painted. Concrete steps have been built to replace wooden steps in front of the pumps used for drinking purposes. The walk on the reservoir embankment between the old effluent gate-house and a point near Reservoir Lane, a distance of 1,780 feet, has been resurfaced, using ashes from the pumping station, with a very light sprinkling of stone dust on the surface. During the summer from 2 to 4 men were required to police the grounds on Sundays, holidays and evenings.

Waban Hill Reservoir.

The reservoir and gate-house are in good order, and the grass on the embankments was somewhat improved in appearance, as compared with the previous year. A fence 250 feet long, with wrought-iron posts set in concrete, and wrought-iron rails, was built to replace a fence with wooden posts which were decayed. This reservoir is cared for by the force employed at Chestnut Hill Reservoir.

Forbes Hill Reservoir and Standpipe.

Both the woodwork and ironwork of the tower and reservoir gate-chamber and the iron railing around the reservoir have been painted by the attendant permanently employed at the reservoir.

Cast-iron caps have been placed on the posts of the fence surrounding the reservoir, to protect them from the weather. Observations taken during the extreme cold weather of January and February showed that the thickness of ice which formed in the standpipe did not exceed 6 inches.

Spot Pond.

The pond has remained at or near high water during the year, except on four occasions. In January and February the demand for water during the extremely cold weather caused the surface to be drawn down to about 1 foot below high water in each month. From October 3 to 10 and October 24 to 31 water was drawn from the pond for the supply of the District, while the Sudbury Aqueduct was shut off for repairs. On each of these occasions the water fell to about 1½ feet below high water. In addition to the ordinary care given to the reservoir and grounds about the pumping station, 356 cubic yards of sand and gravel and 75 cubic yards of loam have been placed on or above the shores of the pond near the corner of South and Main streets, where the embankment had settled so that the water was encroaching on the loamed area. The regular force employed, with some assistance from men detailed from other parts of the works, has devoted much time to the destruction of gypsy and brown-tail moths. The trees near the pumping station have been kept fairly clean, but the trees on about 50 acres of land at the southerly end of the pond were, at the end of the season, very badly infested with the eggs of gypsy moths. On November 7 the work of thinning out trees on the property of the Board around the pond was begun, for the purpose of improving the character of the wooded areas and of reducing the number of trees to be protected. At the end of the year 66 acres had been gone over, and about 300 cords of wood cut and so treated as to kill the eggs on it. This work is to be continued, and the eggs of the moths on the uncut trees are to be destroyed before spring. During the year 109 property bounds were set around the pond.

Mystic Reservoir.

This reservoir has been in constant use, and is in good order; but the gate-house will probably require a new roof during the coming year. The driveway has been thoroughly repaired by building new

tar concrete gutters at a cost of $355, and by surfacing with 25 tons of broken stone. The tar concrete walk around the reservoir was also repaired.

Fells and Bear Hill Reservoirs.

These reservoirs are cared for by the force employed at Spot Pond. The reservoirs, with their gate-houses and grounds, are in good order.

Arlington Standpipe.

The standpipe has been in service throughout the entire year. The two lower sheets of the standpipe have been painted, in order to obliterate marks made by visitors.

Mystic Lake.

The water in the lake was kept from 2½ to 3 feet below high water from the first of January until the middle of April. During the summer the water was kept about 1 foot below high water. In the early part of October, while work of repairing the dam was in progress, the water in the lake was lowered to about 3½ feet below high-water mark, but was afterward raised, and on January 1, 1905, stood at elevation 14.50 above Boston city base, or 2½ feet below high-water mark. An apron of Portland cement concrete, about 6 feet wide and 2 feet thick, has been built below the outlet dam, to prevent the water falling over the dam from excavating the gravel and undermining the concrete foundations; and the joints of the masonry piers and of the wingwalls have been repointed and grouted. The cost of the apron and pointing was about $370.

The house occupied by the attendant has been reshingled and otherwise repaired, at a total cost of about $225. The house of the Medford Boat Club has been moved to a point about 100 feet west of its former location.

Chelsea Reservoir.

In June an arrangement was made with the Water Commissioners of Chelsea, by which the Board was given permission to draw water from the high-service reservoir in cases of emergency, for supplying other cities and towns in the Metropolitan District; and in consideration of this privilege the Board agreed to make repairs to the lining of the reservoir, which had been badly cracked by the action of frost. This work was done in September by the maintenance department, at a cost of about $3,500.

The reservoir is 177 feet long and 96 feet wide, with semi-circular ends. The inner slopes were originally covered with 4-inch brick-work, laid on 4 inches of Rosendale cement concrete. The cracks were in the lining on the upper portion of the slopes, not more than 4 feet below high-water mark. The repairs consisted in removing the old lining down to a point about 6 feet below the top of the embankment, and replacing it with a much heavier lining of Portland cement concrete. The new lining had a thickness of about 2 feet at the high-water line, decreasing to 9 inches at a point 4 feet below high water, where it joined the old lining. It was put on in two layers, with a coating of asphalt between. The upper layer was put on in blocks 5 feet wide and about 10 feet long, and the upper surface given a granolithic finish.

PIPE LINES.

No extensions were made during the year to the pipe lines owned and maintained by the department. Nineteen leaks were repaired on the pipes, at a cost of $1,579. Sixteen of these were caused by defective joints, one by the breaking of a valve and two by breaks in the mains. One of the last two occurred on February 25, when a 30-inch high-service force main broke on the grounds at Chestnut Hill Reservoir, near the low-service pumping station. This break was caused by the settling of the pipe in filled material. The second break occurred on October 16, when the 16-inch high-service main supplying Winthrop broke at the corner of Beach Street, in Winthrop Avenue, Revere. The cost of repairing the break in the 30-inch pipe, including the damage to grounds, was $626.45; and the cost of repairing the break in the 16-inch pipe, including $250 paid for damage to sewer construction, was $367.53.

During October and the early part of November the 12-inch pipe line on Washington Street in Lynn, from a point 30 feet south of the north line of Suffolk Street to a point 180 feet south of the north line of Amity Street, a distance of 593 feet, was relaid, as it was very badly damaged by electrolytic action. This pipe was laid in 1898.

In July two insulating joints were set in the 48-inch pipe line crossing the Charles River between Boston and Cambridge, near the Boylston Street power station of the Boston Elevated Railway Company; and in December two additional joints were placed in

the same pipe line, one on Massachusetts Avenue near the bridge over the Fitchburg Division of the Boston & Maine Railroad, and one near the Allston station on the Boston & Albany Railroad.

The Ross pressure-regulating valves on the pipes supplying Winthrop and Swampscott, which did not satisfactorily regulate the pressure, have been replaced by valves designed in this office and built by the Waters Governor Company.

The several pipe bridges have been examined, and the bridges over the Pines River were repainted.

Twenty-two recording pressure gages are now in use, connected with the distribution system at different points. The average maximum and minimum elevations of the water, due to the pressure at seventeen points in different parts of the District, are given in Appendix No. 3, Table No. 38.

Venturi Meters.

The number of meters in service in the Metropolitan Water District on January 1, 1905, was 53, the same as on January 1, 1904. A few changes have, however, been made in the size and location of the meters. Two 48-inch meters supplying the low-service district of Boston, which were located near the low-service pumping station at Chestnut Hill, were moved in April to a point on Beacon Street just below the connection between the new pipe from the Weston Aqueduct and the mains leading to Boston. This change was made in order to provide for accurate measurements of the water supplied to the Boston low-service district.

A 10-inch meter on Broadway in Chelsea was moved from its location near the bridge leading to Charlestown to a point near William Street, and a 24-inch valve was set in the pipe line at the latter place. The old location near the Chelsea bridge was very near a sea wall, through which the cold entered, so that the meter could not be used during the winter.

The 8-inch meter supplying the town of Nahant having been found to be too large to measure the minimum flow during the winter months, a 6-inch meter was set on the by-pass, and the meter register was connected in such a way as to measure the flow through either meter. A 10-inch weighted check valve was set on the main line of pipe, and so adjusted that it will open in case the meter at any time fails to furnish a sufficient supply.

Two men have devoted their entire time to the work of reading the meters, winding the registers, and cleaning, oiling, painting and repairing the registers and chambers. All of the chambers have been scraped and painted, the ironwork of the registers has been painted, and the bottom of the chambers covered with cement. Some trouble was experienced on account of freezing of the water in the registers and supply pipes during the extreme cold weather, and for the purpose of preventing this seven of the chambers were covered on the top and sides to a depth of 4 feet from the surface with an insulating coating composed of pitch and cork. The cost of this work was about $70 per chamber.

Electrolysis.

Investigations relative to the injury to the pipes caused by electric currents from the street railway systems have been continued throughout the year. In the annual report for the year 1903 detailed descriptions were given of the injury done to 48-inch pipes in Cambridge, the 24-inch pipes in Chelsea and 12-inch pipes in Lynn, and also of an experimental test of an insulating covering of asphalt and burlap which was being made by the Boston Elevated Railway Company. On April 6 this covering, which was applied in November, 1902, was removed from one length of 48-inch pipe for the purpose of examination. Before the covering was applied the pipe was carefully cleaned and the pits dug out and located. Upon removing the covering many new pits were found, and in some cases one large pit was found where there were two or three separate pits before the covering was put on. The number of pits in the pipe had increased from 80 in 1902 to 496 in 1904.

The railway engineers suggested that possibly the pits were not all dug out before the pipe was covered, and therefore recovered it for a further test. They have since made the following experimental tests, which indicate that the covering has little if any value under some circumstances.

A short piece of 4-inch pipe, covered in the same manner as the large pipe, was buried in dry earth in a box, and a cast-iron plate was buried 1.25 feet from the pipe. In one test tar was used in the covering, and in another asphaltum. The pipe and plate were connected in the regular trolley circuit of 500 volts. While the earth was dry the resistance between the pipe and the plate with the tar covering was 700 megohms, and with the asphaltum covering 34

megohms. The earth was then saturated with salt water, and the resistance quickly diminished, and after seven to ten days disappeared.

For the purpose of diminishing the injury which was being done to the two lines of 36-inch pipe crossing under the Charles River near the power station of the Boston Elevated Railway Company in Cambridge, two 48-inch insulating joints were set in July, one on either side of the river. Each of these joints was composed of two flanged pieces of 48-inch pipe, bolted together with a gasket of pure rubber ½ of an inch thick between the flanges. The bolts joining the flanges were covered with rubber tubing ⅛ of an inch thick, and the nuts were insulated from the casting by means of a washer of rubber ½ an inch thick. The joints have a resistance of from 100 to 200 ohms when the pipe is filled with water, and are enclosed in water-proof chambers, to prevent the entrance of ground water.

These joints reduce the quantity of electricity leaving the 36-inch pipes in the river from 25 ampères to less than 5 ampères, and reduce the quantity flowing along the pipes toward the power station at a point on North Harvard Street near Franklin Street from 65 ampères to 40 ampères. The joints were expected to protect the pipes in the river, at the expense, to some extent, of other portions of the pipe line; and the measurements of currents appear to show that the effect has been substantially as expected, as the quantity of electricity leaving the pipe between Western Avenue, Brighton, and the river, was increased about 25 ampères.

As these joints reduced the quantity of electricity flowing along the pipe line, the railway company desired to set similar joints at other points, and late in the year an arrangement was made for the setting of four additional 48-inch joints. Two of these were set in December, one at Porter's Square in Cambridge and the other near the Allston station on the Boston & Albany Railroad. Both of these joints are on the same line of 48-inch pipe as the two joints set in July, one being about 500 feet south and the other 7,500 feet north of the Charles River.

As the amount of current flowing along the pipes at different times depends upon the amount of power developed at these times at the different power stations, many observations are necessary to determine the average quantity flowing even for a single day, and these have not been taken since the last joints were installed; but enough measurements have been taken to warrant the statement that

the introduction of the joint at Porter's Square has substantially stopped the flow of electricity along the pipe at that point. The conditions have been changed so as to increase the amount of electricity leaving the pipe north of the joint, but there appears to be at present not more than 40 ampères flowing along and leaving the pipe line, in place of 90 ampères; and there has also been a very marked reduction in the difference of potential between the pipes and the rails of the street railway company.

The measurements thus far taken appear to indicate that the effects of setting an insulating joint somewhere near the middle of a pipe line, one portion of which is electrically positive and another negative to the car tracks, are as follows: —

1. To stop the direct flow of electricity along the pipe line at the point where the joint is set, and to reduce considerably the amount of electricity flowing along other parts of the pipe line.

2. To lower the average potential of the pipe line on the negative or power station side of the joint.

3. To raise the average potential of the pipe line on the positive side of the joint.

4. To maintain a difference of potential of several volts between the positive and negative sides of the joint, and to produce conditions tending to increase electrolytic action at that point, unless the joint is carefully located in dry ground.

5. To cause a new distribution of electrical conditions, under which the two sections of the pipe line become similar to the original line, with one portion of each positive and the other negative to the car tracks, so that the number of positive areas is increased by one for each joint.

Both in August and November, 1903, the attention of the officials of the Boston & Northern Street Railway Company was called to the serious injury which had then been done to our pipes, both in Chelsea and Lynn, by the currents of electricity returning to its power stations. Excavations made in November in Lynn showed that there were pittings in the 12-inch pipe in Washington Street .45 of an inch in depth, leaving only .25 of an inch of the original thickness of iron. As it was not deemed prudent to continue to risk the failure of this pipe line, it was relaid during the past year for a length of 593 feet. All of this pipe was laid in 1898, and when removed it was badly decomposed, and in several places very little of the original metal of the pipe remained. The officials of the

12-INCH PIPE IN WASHINGTON STREET IN LYNN, PITTED BY ELECTROLYSIS (REPLACED).

railway company were notified that the pipes were to be relaid before the work was commenced, and were asked if they desired to adopt any preventive measures, but they did not do so; and on December 5, after the pipe was relaid, measurements showed that there were 20 ampères of electric current leaving the relaid section. It is probable that, if nothing is done to alter the conditions, it will be necessary to again relay these pipes not later than 1910.

The regular annual survey to determine the relative electrical potential of the Metropolitan pipe lines and the street railway tracks, and the amount of electricity flowing on the pipes at the several gaging stations, was made in April. In making these surveys voltmeter readings were made at each station every twelve seconds, for a period of five minutes. The figures are obtained from readings taken between 9 A.M. and 4 P.M. during the months of March and April, and do not represent the extreme results which would be obtained during the hours of maximum travel. The average of these readings, compared with similar readings made in 1903, are given in the following table. They show that the electrical pressures have been generally reduced during the past year over the entire distribution system.

Summary of Relative Potentials of Metropolitan Water Works Pipes and the Electric Car Tracks in the Metropolitan District for the Years 1903 and 1904.

Location.	Date.	Pipe Negative. Length (Linear Feet).	Pipe Negative. Difference of Potential (Volts). Maximum.	Average.	Minimum.	Pipe Positive. Length (Linear Feet).	Pipe Positive. Difference of Potential (Volts). Maximum.	Average.	Minimum.
Low-service Pipe Lines.									
Easterly 48-inch line, Chestnut Hill Reservoir to Spot Pond, via Malden.	1903	31,500	7.8	4.00	−.6	14,000	5.1	1.60	−1.6
	1904	28,150	6.4	3.97	.4	17,350	2.6	1.23	−.6
Change during year,	-	-	−1.4	−.03	−.2	-	−2.5	−.37	−1.0
Westerly 48-inch line, Chestnut Hill Reservoir to Spot Pond, via Medford.	1903	17,000	6.1	2.45	.3	15,700	9.0	4.00	.6
	1904	18,400	5.2	1.81	−.8	14,300	8.8	3.63	−.3
Change during year,	-	-	−.9	−.64	+.5	-	−.2	−.37	−.3
42-inch line, Malden to Chelsea,	1903	12,700	6.5	3.55	2.5	2,600	3.6	1.09	1.0
	1904	12,300	6.2	2.81	1.4	3,000	3.6	1.07	1.0
Change during year,	-	-	−.3	−.74	−1.1	-	-	−.02	.0
Low-service main, Somerville to Arlington,	1903	27,250	4.8	1.60	−.6	-	-	-	-
	1904	24,350	5.0	.76	−1.2	2,900	2.1	.65	.
Change during year,	-	-	+.7	−.84	+.6	-	-	-	-

Summary of Relative Potentials of Metropolitan Water Works Pipes and the Electric Car Tracks in the Metropolitan District for the Years 1903 and 1904 — Concluded.

Location.	Date.	Pipe Negative.				Pipe Positive.			
		Length (Linear Feet).	Difference of Potential (Volts).			Length (Linear Feet).	Difference of Potential (Volts).		
			Maximum.	Average.	Minimum.		Maximum.	Average.	Minimum.
Supply Pipe Lines.									
Terminal Chamber of Weston Aqueduct to Chestnut Hill Reservoir.	1903	13,400	4.0	.56	—1.5	20,800	10.0	2.82	.0
	1904	14,800	5.0	1.17	—1.3	19,400	8.4	2.91	—1.0
Change during year,	-	-	+1.0	+.61	—.2	-	—1.6	+.09	+1.0
Northern High-service Pipe Lines.									
Medford to Revere,	1903	48,700	10.5	2.85	—.4	5,900	2.6	.74	—1.5
	1904	47,900	5.0	1.56	—1.0	6,700	1.8	.47	—1.1
Change during year,	-	-	—5.5	—1.29	+.6	-	—.8	—.27	—.4
Revere to Lynn,	1903	23,850	3.4	1.92	—1.2	9,550	10.4	2.59	—2.4
	1904	28,850	3.0	.82	—.6	4,550	8.8	3.67*	1.1
Change during year,	-	-	—.4	—1.10	—.6	-	—1.6	+1.08	—1.3
Spot Pond to Stoneham,	1903	-	-	-	-	10,250	27.0	19.40	12.0
	1904	-	-	-	-	10,250	21.0	12.22	3.0
Change during year,	-	-	-	-	-	-	—6.0	—7.18	—9.0
Southern High-service Pipe Lines.									
Belmont and Watertown to Quincy,	1903	60,750	35.0	3.80	—.6	2,500	2.3	.84	.7
	1904	61,250	60.0	3.63	—1.8	2,000	1.2	.44	.1
Change during year,	-	-	+25.0	—.17	+1.2	-	—1.1	—.40	—.6
Southern Extra High-service Pipe Lines.									
West Street, Hyde Park,	1903	-	-	-	-	1,550	17.5	10.35	5.2
	1904	-	-	-	-	1,550	13.0	7.51	3.0
Change during year,	-	-	-	-	-	-	—4.5	—2.84	—2.2

* This average is high on account of reduced length of the district in 1904; the average for the same length in 1903 was 4.93.

At a few points, however, the conditions are worse than in 1903. At the corner of Reservoir Lane and Boylston Street in Brookline the voltage between the pipe and the rails has increased from $2\frac{1}{2}$ to 5 volts, possibly due to increased traffic on the Boston & Worcester line. On Adams Street in Milton, near the East Milton station, the average voltage has increased from 18 volts in 1903 to 22 volts in 1904, and the maximum from 35 to 60 volts. This is due to poor track construction, and lack of return feeders on the Old Colony Street Railway Company's tracks. Early in the year the Boston & Northern Street Railway Company was notified that there was a large difference of potential between our pipes and their tracks on Main Street in Stoneham, and that a large quantity of electricity was flowing along our pipe. During the past year the railway

12-INCH PIPE IN WASHINGTON STREET IN LYNN, PITTED BY ELECTROLYSIS (REPLACED).

company has relaid the tracks between Melrose Highlands and Stoneham Square, and provided better returns for the current, so that the conditions have been greatly improved; but even now there is considerable current flowing along our pipe in Main Street.

In January the attention of the Old Colony Street Railway Company was called to the fact that a current of from 15 to 45 ampères had been measured flowing on our 12-inch pipe in West Street in Hyde Park, with differences of from 5 to 18 volts between the pipe and the rails. In June our pipe was uncovered at several points for examination, and pits about $\frac{1}{16}$ of an inch in depth were found on several pipes. A service pipe of the Hyde Park Water Company was found to be resting upon the 12-inch pipe, making an electric contact by means of which about 10 ampères of electricity passed from the Metropolitan main to the pipes of the Hyde Park Water Company. By raising the service pipe and breaking the electric connection, the flow of electricity along our pipes was reduced about one-half.

Clinton Sewerage.

The Clinton sewage disposal works were in daily operation during the whole year. The amount of sewage pumped and filtered was about 43,000 gallons per day less than during the preceding year, notwithstanding the considerable number of additional house connections which have been made with the system. The decrease is due in part to the smaller quantity of water leaking into a very leaky section of the town sewer, located close to the river, between the Lancaster Mills and Germantown, and to the large increase in the number of water meters in Clinton, by which the waste of water is checked.

Following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons),	740,000
Daily average quantity of coal consumed (pounds),	1,295
Gallons pumped per pound of coal,	570
Number of days pumping,	366
Cost of pumping: —	
Labor,	$1,389 33
Fuel,	1,092 18
Repairs and supplies,	756 91
Total for station,	$3,238 42
Cost per million gallons pumped,	$11 99
Cost per million gallons raised 1 foot high,	26

The increase in the cost of labor, as compared with the cost the preceding year, is due mainly to the employment of an additional engineer to operate the pump nights during the spring when the quantity of sewage was large. The increase in the cost of repairs and supplies is due mainly to the purchase of new plungers for the pump and the repair of the old plungers for future use, these items costing $520.

Filter-beds.

During the year 8 settling basins and about .83 of an acre of small filter-beds on which to filter the water from the underdrains of the settling basins were added, as already described in the portion of the report relating to Construction.

In the latter part of the year from 2 to 3 inches of the dirty sand or gravel were removed from the surfaces of the 19 beds from which all soil had been removed when they were built. The total quantity of material removed was 5,444 cubic yards, which was hauled an average distance of 540 feet to dispose of it. The total cost of removing the material and disposing of it was $1,858.19, or 34 cents per cubic yard. This work was done by a day-labor force.

The settling basins have been in operation continuously since November 14. The sewage is allowed to run through a basin for a time, when it is shut off and turned through another. After a week's use, sludge about 6 inches deep accumulates on the bottom of the basin near the inlet, but near the outlet there is very little. These basins have been used for too short a time to warrant any statement as to the best method of using them or as to their effect.

During the warmer part of the year sewage was applied in about the same quantity per bed to the 19 beds from which all soil had been removed and to the 6 beds from which soil had not been removed; but the latter beds were not used during the colder part of the year.

In March, April and May the sewage was pumped nights as well as days, and for nearly a week the pump was operated continuously.

During the warmer portion of the year, from April 8 to November 27, the sewage was applied to the beds at a rate which averaged about 32,000 gallons per acre per day. For the first half hour after beginning pumping in the morning, when the sewage contains more sludge than at other times, it was turned on one of two selected beds. These 2 beds were used alternately for periods of about 3

weeks, one being in use while the other was drying and being cleaned. The remaining 23 beds were used in rotation, and all the sewage was run upon a single bed, having an area of a little less than 1 acre, for about 1½ hours, the amount per application being about 181,000 gallons, each bed being used about once in 6 days.

During the colder portion of the year, when the temperature was below 15° above zero, all the sewage of one day's pumping was turned upon one of 5 improved beds, which had been prepared with furrows 3 feet 6 inches apart. The average amount per application was 580,000 gallons, and each furrowed bed was used about once in 10 days. When the temperature was higher than 15° above zero, the sewage was applied to the beds which had not been furrowed, at the rate of 290,000 gallons per application, and each acre was used about once in 10 days.

The degree of purification was about the same as in the preceding year. Taking the year as a whole, the amount of nitrification has been about the same as in the preceding year, but much lower than in the years 1900 to 1902. It was much higher in the last half of the year than in the first. The results of chemical analyses of the sewage and effluent are given in the following table: —

[Parts per 100,000.]

	1900.	1901.	1902.	1903.	January to June, 1904, inclusive.	July to December, 1904, inclusive.	Whole Year, 1904.
Albuminoid ammonia, sewage,	1.380	1.0025	1.0517	.9233	.7467	.8467	.7967
Albuminoid ammonia, effluent,	.089	.0741	.0891	.0782	.0752	.0620	.0686
Per cent. removed,	94	91	89	92	90	93	91
Oxygen consumed, sewage,	14.84	10.73	8.85	8.65	6.72	10.42	8.57
Oxygen consumed, effluent,	1.09	.82	1.15	1.12	1.07	.91	.99
Per cent. removed,	93	91	84	87	84	91	88
Free ammonia, sewage,	3.9500	3.4533	4.3284	3.8292	3.26	4.67	3.97
Free ammonia, effluent,	1.0631	.5792	.6862	1.0185	1.08	.89	.99
Per cent. removed,	73	83	84	73	67	81	75
Nitrogen as nitrates, effluent,	.7300	.9298	.9815	.4168	.2129	.5963	.4046

The cost of maintaining the filter-beds, exclusive of the cost of removing the dirty sand or gravel from the 19 beds, has been as follows: —

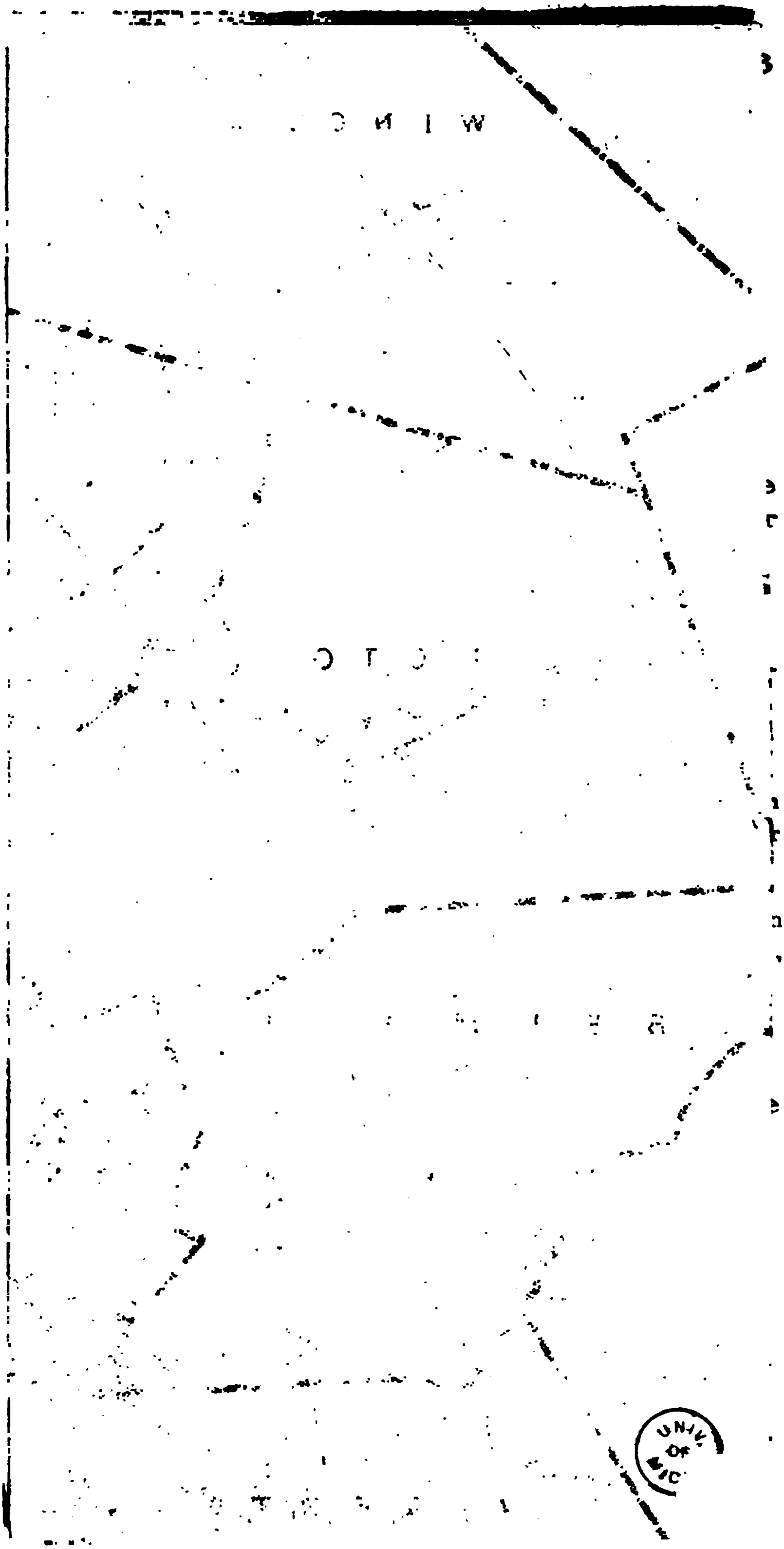
Labor,	$2,198 16
Repairs and supplies,	42 15
Total,	$2,240 31
Cost per million gallons filtered,	8 29

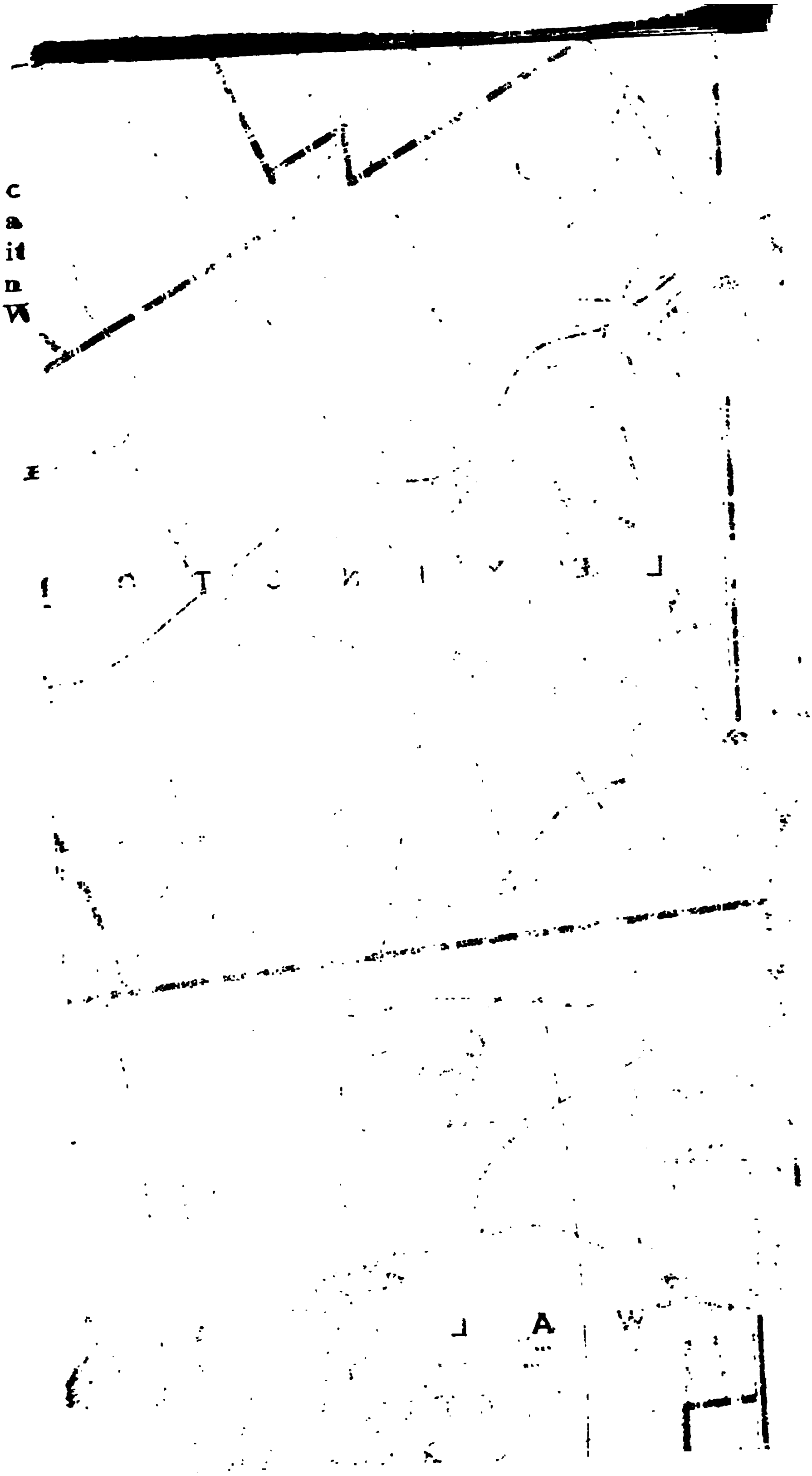
Appended to this report are tables of contracts giving the amount of work done and other information, a statement of the cement tests, a long series of tables relating to the maintenance of the Metropolitan Water Works, tables showing the length of main pipes and number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1904.

Respectfully submitted,

FREDERIC P. STEARNS,
Chief Engineer.

Boston, January 1, 1905.





REPORT OF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1904.

ORGANIZATION.

The engineering organization during the year has been as follows: —

Division Engineers: —

FREDERICK D. SMITH, .	In charge of maintenance, South Metropolitan System, and construction of High-level Sewer in Quincy.
FRANK I. CAPEN, . .	In charge of construction of High-level Sewer in Roxbury, and of maintenance and construction, North Metropolitan System.
FRANK A. EMERY, . .	In charge of office, drafting room and records.

In addition to the above, there were employed at the end of the year 8 engineering and other assistants.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 91 square miles, and of the South Metropolitan District at 102 square miles, — a total, inclusive of water surfaces, of 193 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table: —

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1904.

	City or Town.	Area (Square Miles).		Estimated Population.	
North Metropolitan District.	Arlington,	5.20		10,400	
	Belmont,	4.66		5,200	
	Boston (portions of),	3.45		91,400	
	Cambridge,	6.11		102,200	
	Chelsea,	2.24		38,400	
	Everett,	3.34		30,100	
	Lexington,*	5.11		2,800	
	Malden,	5.07		42,000	
	Medford,	8.35		22,700	
	Melrose,	3.73		14,700	
	Revere,	5.86		13,900	
	Somerville,	3.96		71,700	
	Stoneham,	5.50		6,500	
	Wakefield,	7.65		10,500	
	Winchester,	5.95		8,600	
	Winthrop,	1.61		8,000	
	Woburn,	12.71	90.50	15,400	494,500
South Metropolitan District.	Boston (portions of),	20.92		155,800	
	Brookline,	6.81		25,100	
	Dedham,*	9.40		7,400	
	Hyde Park,	4.57		14,700	
	Milton,	12.59		7,900	
	Newton,	18.03		39,900	
	Quincy,	12.56		28,400	
	Waltham,	13.63		27,600	
	Watertown,	4.04	102.55	11,500	318,300
	Totals,		193.05		812,800

* Part of town.

METROPOLITAN SEWERS.

Sewers Purchased and Constructed and their Connections.

Within the Sewerage Districts there are now 95.55 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 87 miles of Metropolitan sewers having been constructed by the Metropolitan boards.

The position, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

North Metropolitan System.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1904.	Special Connections. Character or Location of Connection.	Special Connections. Number in Operation.
Boston: —					
Deer Island,	6' 3" to 9',	1.367	4	-	-
East Boston,	9' to 1',	5.467	18	-	-
Charlestown,	6' 7"×7' 5" to 1',	3.292	13	Navy Yard, Almshouse,	8
Winthrop,	9',	2.864	7	Club house,	1
Chelsea,	8' 4"×9' 2" to 1' 10"×2' 4",	5.128	7	Bakery, Rendering works, Metropolitan Water Works blow-off,	3
Everett,	8' 2"×8' 10" to 4' 8"×5' 1",	2.925	6	Metropolitan Water Works blow-off,	1
Malden,	3' 9"×4' 1" to 1' 8",	3.931*	25	Metropolitan Water Works blow-off,	1
				Private houses,	105
Melrose,	1' 10"×2' 9" to 10",	6.099†	31	Private houses,	100
Cambridge,	5' 2"×5' 9" to 1' 3",	7.167	28	Slaughter-house, City Hospital,	2
Somerville,	6' 5"×7' 2" to 1' 10"×2' 3",	3.471	10	Tannery,	1
				Slaughter-houses (3),	1
				Car-house,	1
				Stable,	1
Medford,	4' 8"×5' 1" to 10",	5.359	20	Armory building,	1
				Private houses,	5
				Stable,	1
Winchester,	2' 11"×3' 3" to 1' 3",	6.428	12	Tannery,	2
				Private houses,	2
				Gelatine factory,	1
Stoneham,	1' 3" to 10",	.010	4	-	-
Woburn,	1' 10"×2' 4" to 1' 3",	.933	3	Glue factory,	1
Arlington,	1' 6" to 10",	3.520‡	33	Private houses,	92
Belmont,§	-	-	3	-	-
Wakefield,§	-	-	1	-	-
Revere,	4' to 8',	.048	1	-	-
		58.004‖	226		330

* Includes .988 of a mile of sewer purchased from the city of Malden.

† Includes .736 of a mile of sewer purchased from the town of Melrose.

‡ Includes 2.631 miles of sewer purchased from the town of Arlington.

§ The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

‖ Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan System.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1904	Special Connections. Character or Location of Connection.	Special Connections. Number in Operation.
Boston (Back Bay),	6' 6" to 5' 6",	1.500*	8	Private house,	1
				Administration building, Boston Park Department,	1
				Simmons College buildings,	1
Boston (Brighton),	5' 6" to 12",	3.714†	11	Abattoir,	3
Boston (Dorchester).	3'×4' to 2' 6"×2' 7",	2.870‡	6	-	3
Boston (Roxbury),	6' 6"×7', 4' 0",	1.430	-	-	-
Boston (West Roxbury).	9' 3"×10' 2" to 12",	7.011	6	Parental school,	1
				Lutheran Evangelical Church,	1
Brookline,	5' 6",	0.127	2	-	-
Dedham,	4'×4' 1" to 3' 9"×3' 10",	2.359	4	-	-
Hull,	60" pipe,	0.750	-	-	-
Hyde Park,	10' 7"×11' 7" to 4'×4' 1",	4.527	18	Private buildings,	2
Milton,	11'×12' to 8",	3.600	7	-	-
Newton,	4' 2"×4' 9" to 1' 3",	2.911	6	Private houses,	2
Quincy,	11' 3"×12' 6" to 60" pipe,	6.007	8	-	-
Waltham,	3' 6"×4',	0.001	1	-	-
Watertown,	4' 2"×4' 9" to 12",	0.750§	5	Factory,	2
		37.548	72		17

* Includes .355 of a mile of sewer purchased from the city of Boston.
† Includes .026 of a mile of sewer purchased from the town of Watertown.
‡ Includes 1.24 miles of sewer purchased from the city of Boston.
§ Includes .025 of a mile of sewer purchased from the town of Watertown.

Cost of Construction.

The cost of the 95 miles of Metropolitan sewers enumerated above, including seven stations, siphons and appertaining structures, may be summarized as follows: — *

North Metropolitan System,	$6,086,569 91
South Metropolitan System,	7,580,262 47
	$13,666,832 38

Construction and Additions during the Year.

The last report indicated that 93.86 miles of Metropolitan sewers had been constructed to December 31, 1903. There has consequently been added, during the year under review, a length of 1.69 miles. This includes 0.48 of a mile of High-level Sewer, authorized by chapter 424 of the Acts of 1899; 0.939 of a mile of sewer, authorized by chapter 242 of the Acts of 1903, to provide sewerage facilities for the town of Revere; 0.248 of a mile of sewer, authorized by chapter 336 of the Acts of 1903, to provide an additional outlet for the

* For detailed statement of cost, see report of Board, p. 52.

sewage of Belmont; and 0.025 of a mile of sewer in Lake Street, Winchester, — all referred to in detail later in this report.

The following table gives details of areas, populations, local sewer mileage and other data for the whole Metropolitan Sewerage System: —

North Metropolitan System.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	Connections made with Metropolitan Sewers. Public.	Connections made with Metropolitan Sewers. Special.
90.50	494,500	558.18	387,327	78.3	226	330
South Metropolitan System.						
102.55	318,300	406.32	147,761	46.4	72	17
Entire Metropolitan District.						
193.05	812,800	964.50	535,088	65.8	298	347

Of the estimated gross population of 812,800 on December 31, 1904, 535,088, representing 65.8 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 964.5 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan system by 298 public and 347 special connections. It appears, also, that there has been during the year an increase of 30.4 miles of local sewers connected with Metropolitan systems, and that 24 public and 8 special connections have been added.

Pumping Stations and Pumpage.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with corresponding volumes for the previous year: —

Pumping Station.	Average Daily Pumpage. Jan. 1, 1903 to Dec. 31, 1903.	Average Daily Pumpage. Jan. 1, 1904 to Dec. 31, 1904.	Increase during the Year. Gallons.	Increase during the Year. Per Cent.
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	53,800,000	57,200,000	3,400,000	6.3
East Boston,	51,600,000	55,000,000	3,400,000	6.6
Charlestown,	29,900,000	31,100,000	1,200,000	4.0
Alewife Brook,	3,831,000	3,546,000	285,000*	7.4*
Quincy,	3,042,000	3,651,000	609,000	20.0
Ward Street (from Oct. 14 to Dec. 31, 1904),	-	12,700,000	-	-

* Decrease.

CONSTRUCTION ON THE NORTH METROPOLITAN SYSTEM.

With the completion of the branch sewer to the town of Revere and extension of the Cambridge branch to Belmont, begun in 1903, all Metropolitan sewers on this system authorized to date have been constructed. The Revere extension was opened for service on October 8, and the Belmont extension on July 20, 1904.

Details of the construction are given in the following report.

Extension to Revere.

Section 61, Chelsea (Construction in Part by Day Labor, in Part by Contract).

Division Engineer in Charge. — **Frank I. Capen.**
Superintendent of Construction by Day Labor. — **Henry J. Wright.**
Contractor for Tunnel Work. — **Charles A. Haskin, Boston, Mass.**

This section comprises 2,530 linear feet of 54-inch brick sewer and 999 linear feet of 48-inch brick sewer built in open cut, and 608 linear feet of 54-inch brick sewer built in tunnel.

It joins Section 10 of the North Metropolitan trunk sewer near the junction of Eastern Avenue and Marginal Street, Chelsea, and extends northerly along Eastern Avenue and across the land of the Boston & Maine Railroad to Crescent Avenue, crossing under the tracks of the Grand Junction branch of the Boston & Albany Railroad, the tidal inlet known as Bass Creek, the Willoughby Street main sewer of the city of Chelsea, and the tracks of the Eastern Division of the Boston & Maine Railroad.

At the beginning of the year construction by day work was already in progress, as described in the last report, and about 345 linear feet of 48-inch sewer northerly from the Eastern Division of the Boston & Maine Railroad and 600 linear feet of 54-inch sewer southerly from Bass Creek had been built. This construction was continued at an average rate of 60 linear feet a week until the remaining 2,584 feet of open cut was completed on October 12, 1904. This included portions between the Eastern Division of the Boston & Maine Railroad and Bass Creek, and a length from 600 feet south of Bass Creek to within 608 feet of the end of the section at Marginal Street.

As the construction in open cut approached Marginal Street, quicksand was encountered in the excavation. During the construction of sections 10 and 12 of the North Metropolitan trunk sewer in Marginal Street in 1892–94, difficulties with boiling quicksand occasioned serious delay and expense in the excavation. To avoid similar delay and expense on this work, a contract was arranged on May 3, 1904, with an expert in compressed air construction, and the work for a length of 608 feet north from Marginal Street was carried out by the pneumatic process in tunnel, under an air pressure of 10 pounds per square inch in excess of that of the atmosphere.

The tunnel heading was in fine silt, making it necessary to support the masonry on piling. Piles, in bents of three, about four feet on centres, were driven in advance of the tunnel heading, which was excavated over the top of the piling, and the pile caps, platform and masonry placed in position under compressed air. The masonry cross-section built was similar to that used in the open cut construction. The work was begun on May 26, and an average rate of progress of 65 feet a week was maintained until its completion on August 11, 1904.

Section 62, Chelsea (Construction in Part by Day Labor, in Part by Contract).

Division Engineer in Charge. — **Frank I. Capen.**
Superintendent of Construction by Day Labor. — **Henry J. Wright.**
Contractor for Tunnel Work. — **Charles A. Haskin, Boston, Mass.**

This section comprises 2,788 linear feet of 48-inch brick sewer, 1,320 feet in tunnel and 1,468 feet in open cut, beginning on Crescent Avenue, at Eastern Avenue, and running northeasterly across marsh land on the line of Crescent Avenue extended and through Crescent Avenue and its extension to near the tidal inlet, known as Mill Creek, separating Chelsea and Revere.

The construction was fully described in the last report. At the beginning of the year about 540 linear feet in tunnel and about 639 linear feet in open cut had been completed. The work was continued at an average rate of progress of 60 feet a week in open cut and 70 feet in tunnel until its completion on April 1, 1904.

Mill Creek Crossing, Chelsea and Revere (Construction by Day Labor).

Division Engineer in Charge. — **Frank I. Capen.**
Superintendent of Construction by Day Labor. — **Henry J. Wright.**

This work was fully described in the last report. It covers a total length of 387 linear feet. The work of construction was continued by the methods outlined in the report until its completion early in June. All piles driven for supporting the coffer-dam were either cut off or pulled, leaving the waterway of Mill Creek unobstructed.

Extension to Belmont.

Section 63, Cambridge.

Division Engineer in Charge. — **Frank I. Capen.**
Contractor. — **Gow & Palmer, Boston, Mass.**

This section begins on Mt. Auburn Street at Lowell Street, at the end of Section 30 of the Cambridge branch of the Metropolitan sewer, constructed in 1893, and extends westerly along Mt. Auburn Street to Aberdeen Avenue; thence in Aberdeen Avenue and private land, across Homer Avenue, through private land, and across the Watertown branch of the Boston & Maine Railroad to Holworthy Place; through Holworthy Place, Holworthy Street and private land, across Cushing Street and through Cushing Avenue to the Belmont town line.

The construction of this section was fully described in the last report. It comprises 4,780 linear feet of 24-inch by 28-inch and 1,031 linear feet of 22-inch by 28-inch brick sewer in open cut, and about 547 linear feet of 25-inch diameter brick sewer in tunnel. At the beginning of the year about 5,100 linear feet had been completed.

The opening on Mt. Auburn Street at Lowell Street, started on September 17, 1903, was continued until the masonry was completed on March 16, 1904, and the trench partially backfilled; but the remainder of the backfilling was postponed until late in March, when the frost had left the ground.

The tunnel headings, started in December, 1903, were continued until they were completed on March 5, 1904.

CONSTRUCTION ON THE SOUTH METROPOLITAN SYSTEM.

During the year the High-level Sewer, authorized by chapter 424 of the Acts of 1899 and fully described in earlier reports, has been practically completed and put into operation.

At the date of the last report some of the outfall pipes on Section 43 remained to be placed in the harbor. On Nut Island, Section 44, the screen-house and machinery were to be erected, and some filling and grading on the island and the near-by embankments of Section 48 remained to be finished. The connecting chamber at the end of the force-main lines, Section 76, at Parker Hill in Roxbury, remained to be completed, and the Ward Street pumping engines and other machinery to be erected.

The greater part of this work was completed early in the fall, and the pumps at the Ward Street pumping station were started on October 14, since which date the sewage from that portion of the Charles River valley above Vancouver Street, in the Back Bay district of Boston, has been pumped to the High-level Sewer.

This Metropolitan district above Vancouver Street includes most of Brookline, Newton and the Roxbury district of Boston, and the whole of Brighton, Waltham and Watertown. A connection for territory below Vancouver Street leading easterly along Huntington Avenue toward Gainsborough Street, to provide for the sewage of a portion of the Back Bay and Roxbury districts of the city of Boston, remains to be completed. The details of this connection are under discussion with the Charles River Basin Commission and the Sewer Department of the city of Boston. Until this branch is built, the sewage of this small district below Vancouver Street will continue to be pumped by the Boston Main Drainage Works.

On November 22, 1904, the Neponset River valley Metropolitan main sewer was connected with the High-level Sewer at the junction of East River and Monponsett streets, in Hyde Park; and since that date the sewage from Metropolitan territory above this point, including the whole of Hyde Park, Dedham, the West Roxbury district of Boston and part of the town of Brookline, has been disposed of through the High-level Sewer.

The trunk sewer through Quincy and Milton was opened for service on October 14, 1904.

Sewage from the Neponset valley Metropolitan area below Hyde Park, including small portions of Dorchester and Milton, will continue to be discharged through the Boston Main Drainage Works. Sewage from the Quincy pumping station, at present pumped to the Moon Island outlet at Squantum, will be delivered to the High level Sewer through 24-inch force-main pipes to be laid during the coming spring.

A detailed description of the work of the year follows.

Section 43, Quincy and Hull.

Division Engineer in Charge. — **Frederick D. Smith.**
Contractor. — **Hiram W. Phillips, Quincy, Mass. (Two contracts.)**

The section comprises two lines of 60-inch cast-iron outfall pipes, placed below the bed of Boston harbor, extending northerly from Nut Island to west of Peddocks Island. The two lines have an aggregate length of 10,844 feet.

At the beginning of the year 4,569 feet remained to be placed on the easterly line, and considerable backfilling on both lines. The contractor commenced operations for the season about May 1, and the contract work was completed on November 2, 1904. The method of placing the pipes has been fully described in earlier reports.

During the year the pipe was placed at an average rate of 1,100 feet a month. The maximum rate of 48 feet a day was maintained for nearly the entire season. While the backfilling of the easterly line was in progress, one 48-foot length of pipe was crowded off the pile platform, and had to be replaced by the contractor.

Both lines of pipe were subjected to contract tests for tightness after completion, and were found to satisfy contract requirements.

Section 44, Quincy.

Division Engineer in Charge. — **Frederick D. Smith.**
Contractor for sewer, sand-catcher, and screen-chamber and building foundations. — **W. H. Ellis, Boston, Mass.**
Contractor for screen-house superstructure and chimney. — **Woodbury & Leighton Company, Boston, Mass.**

Early in the year the screen-chamber, sand-catcher and building foundations were completed. About May 1 work on the screen-house chimney was begun. The house was designed by Shepley,

Rutan & Coolidge, architects, and is 78 feet long by 60 feet wide and about 40 feet in height. It is built of dark red brick, with rustications of gray headers, with Quincy granite trimmings. It provides a room about 47 by 48 feet for screens and valves; a boiler room 25 by 30 feet; and a coal storage room 25 feet square, providing storage for about 200 tons of coal. In addition, the building contains a large vestibule, office and toilet room. The chimney, about 100 feet high, is placed at the easterly end of the building. The building was completed on October 15, 1904.

In the boiler room are two 80 horse-power, vertical, internally fired, tubular boilers of the Dean type, with shells 80¾ inches in diameter, each boiler having 208 tubes, 2 inches in diameter and 10 feet long. These boilers were built by Edward Kendall & Sons, Cambridge, and furnish steam for heating the building and operating the screens in the screen room.

There are four screens, two in each duplicate channel of the screen room. They are about 12 feet square, with clear openings between bars of ¾ inch, so that they will intercept practically all the floating matter in the sewage that might be found objectionable in the harbor. They are raised and lowered by small reversing engines of the Fitchburg type. The screens and connections were furnished and erected by the Lockwood Manufacturing Company of East Boston. Matters intercepted on the screens are pressed and afterwards burned under the boilers.

The house and machinery were ready for operation early in October. Considerable grading on Nut Island remains to be completed during the coming year.

Sections 45, 46 and 47, Quincy.

These contracts were completed prior to December 31, 1903.

Filling on Embankment and Completing Rock Island Road, Section 48, Quincy.

Division Engineer in Charge. — Frederick D. Smith.
Contractor. — J. J. Moebs, Boston, Mass.

For completing embankment filling, and loaming and grading the slopes, a contract was arranged early in the year, involving the placing of 6,600 yards of sand filling, 4,400 yards of loam on embankment slopes, and about 670 yards of broken stone over the line

of Rock Island Road, so called, passing the embankment. The work of filling and grading commenced about June 10, and was completed about October 15, 1904.

Sections 48 to 75, inclusive.

The work through Quincy, Milton, Hyde Park and Roxbury was completed to the end of the force mains for the Ward Street pumping station at Parker Hill, Roxbury, prior to the beginning of the year, and has been fully described in earlier reports, under sections 48 to 75.

Section 76, Roxbury.

Division Engineer in Charge. — **Frank I. Capen.**
Contractor. — **H. P. Nawn, Boston, Mass.**

This section consists of duplicate lines of 48-inch cast-iron force mains and appurtenances, extending from near the Ward Street pumping station to the end of the Section 75 tunnel near the corner of St. Alphonsus and Tremont streets, Roxbury. The easterly line extends through Ward, Phillips, Conant, Oregon, Smith and St. Alphonsus streets, and the westerly through Ward and St. Alphonsus streets.

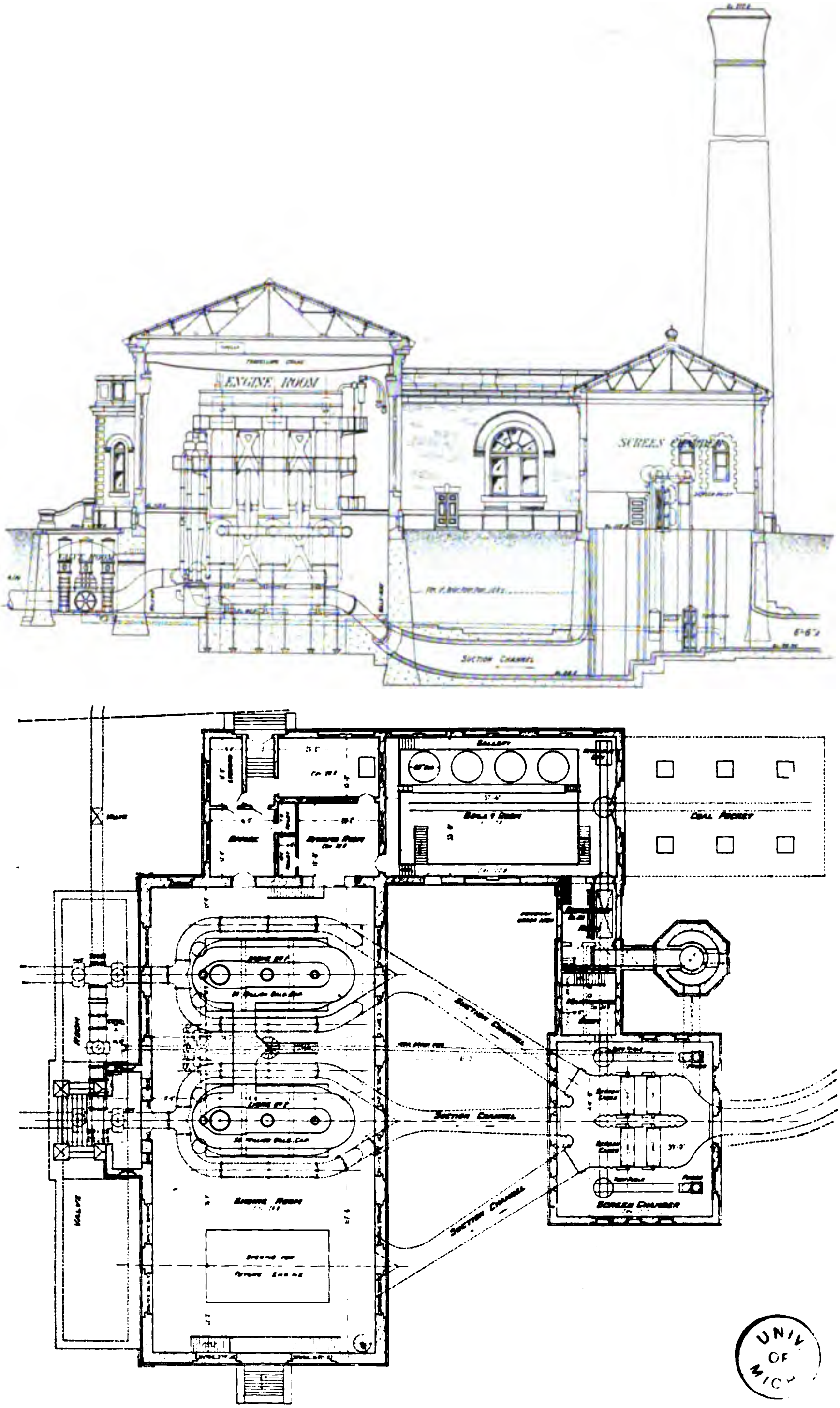
The cast-iron pipe under this contract was all laid last year, as described in the third annual report. At the beginning of the year a small amount of masonry remained to be introduced in the valve-chamber at the upper end of the pipe lines on St. Alphonsus Street. This was completed the latter part of January. During the year controlling valves have been installed in this chamber, and the lines tested for leakage. A pressure of about 60 pounds per square inch, as specified in the contract, was applied to the pipes, which were found sufficiently tight.

Section 77, Roxbury.

Division Engineer in Charge. — **Frank I. Capen.**
Contractor for Pumping Station and Connections. — **L. P. Soule & Son, Boston, Mass.**
Contractor for Pumping Plant. — **Allis-Chalmers Company, Milwaukee, Wis.**

This section includes the Ward Street pumping station and its connections with force mains and suction sewer.

The pumping station buildings were described at considerable length in the last annual report. At the beginning of the year the station walls were completed and the roof partially built. The



WARD STREET PUMPING STATION—VERTICAL SECTION AND GROUND PLAN.

engine house roof was finished in January, and the boiler house roof in February.

The interior finish, excepting the basement and engine room floors and the carpenter work at the main entrance on Ward Street, was completed early in May. This main entrance and the basement floor were finished in September, after the heavy parts of the machinery had been moved into the building. Work is now in progress on the finished tile floor in the engine room.

Early in the spring the work of subgrading the grounds and roads about the buildings was carried out by day labor, under the direction of the Engineer.

From April to September the 48-inch controlling valves on the force mains in the station basement, the Venturi meter on the westerly force main, and a 36-inch cast-iron by-pass pipe, extending from the force mains around the station to the suction sewer, were placed by day labor, under the direction of the Engineer.

The Allis-Chalmers Company of Milwaukee, who are furnishing and erecting the pumping engines and steam plant at the station, commenced erection early in January. The plant consists of two 50-million gallon, vertical, triple-expansion pumping engines, with steam cylinders of 21, 38 and 58 inches diameter. The pump plungers are 48 inches in diameter, with 60-inch stroke. The maximum contract lift is 45 feet. The steam is furnished by four 93-inch diameter, internally-fired, vertical tubular boilers of the Dean type, each having 308 tubes, 2 inches in diameter and 15 feet long. It is intended to use two boilers with an engine, and duplicate lines of steam piping have been arranged and installed, so that each boiler can be used with either engine.

For lighting the station, two direct-connected generators, having a capacity of 350 16-candle-power lamps each, were furnished and installed by the American Engine Company of Bound Brook, N. J.

In the screen room are four screens, two in each duplicate channel. They are about 10 feet square, with clear openings between bars of $\frac{3}{4}$ inch, so that they will intercept practically all the floating matters in the sewage that would interfere with the operation of the pumps. These screens are raised and lowered by small reversing engines of the Fitchburg type. The screens and connections were furnished and erected by the Lockwood Manufacturing Company of East Boston.

Engine No. 2 was started first on September 19, and engine No. 1 on September 24. The formal engine tests specified in the contract have not been made, but satisfactory arrangements for the use of these engines prior to their formal test and acceptance have been made by the Board with the contractor, so that the station was put into regular service for the disposal of sewage on October 14.

Connection of Section 78 (Suction Sewer) with the Charles River Valley Sewer at Ruggles Street, Roxbury (Construction by Day Labor).

Division Engineer in Charge. — **Frank I. Capen.**
Superintendent of Day Labor Construction. — **Henry J. Wright.**

During the months of July and August the actual connection between Section 78 of the High-level Sewer and Section A of the original Charles River valley main sewer was made at the corner of Vancouver and Ruggles streets. The connection involved the introduction of a bellmouth and valve-chamber along the line of the Charles River sewer. The masonry section involved a 12-inch brick arch and an invert of Portland masonry, reinforced with Portland concrete, the whole supported on a platform and pile foundation.

The chamber introduced provides for turning the sewage flow in the Charles River main sewer either to the Boston Main Drainage Works or to the Metropolitan High-level Sewer.

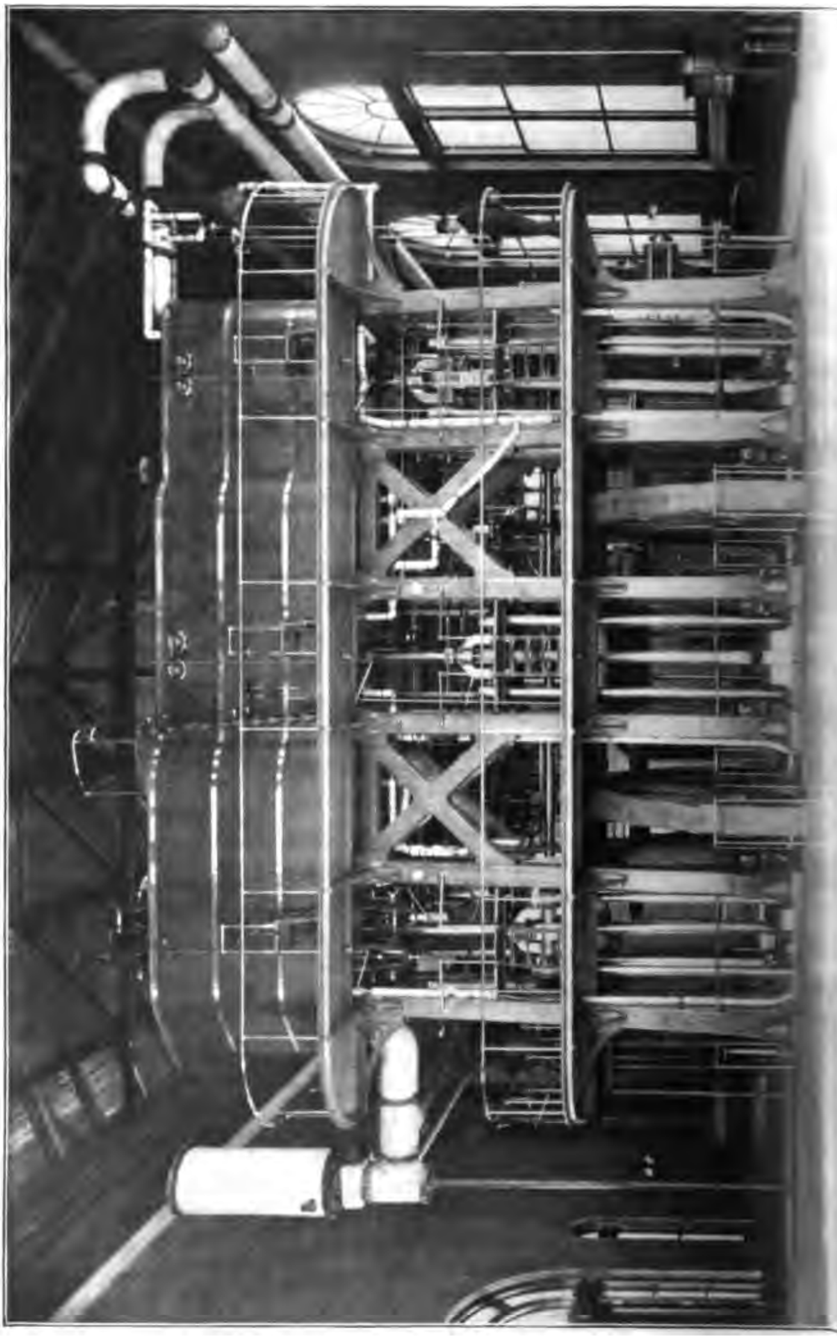
Temporarily during construction the flow in the Charles River sewer was carried across the line of the work in 48-inch cast-iron pipes.

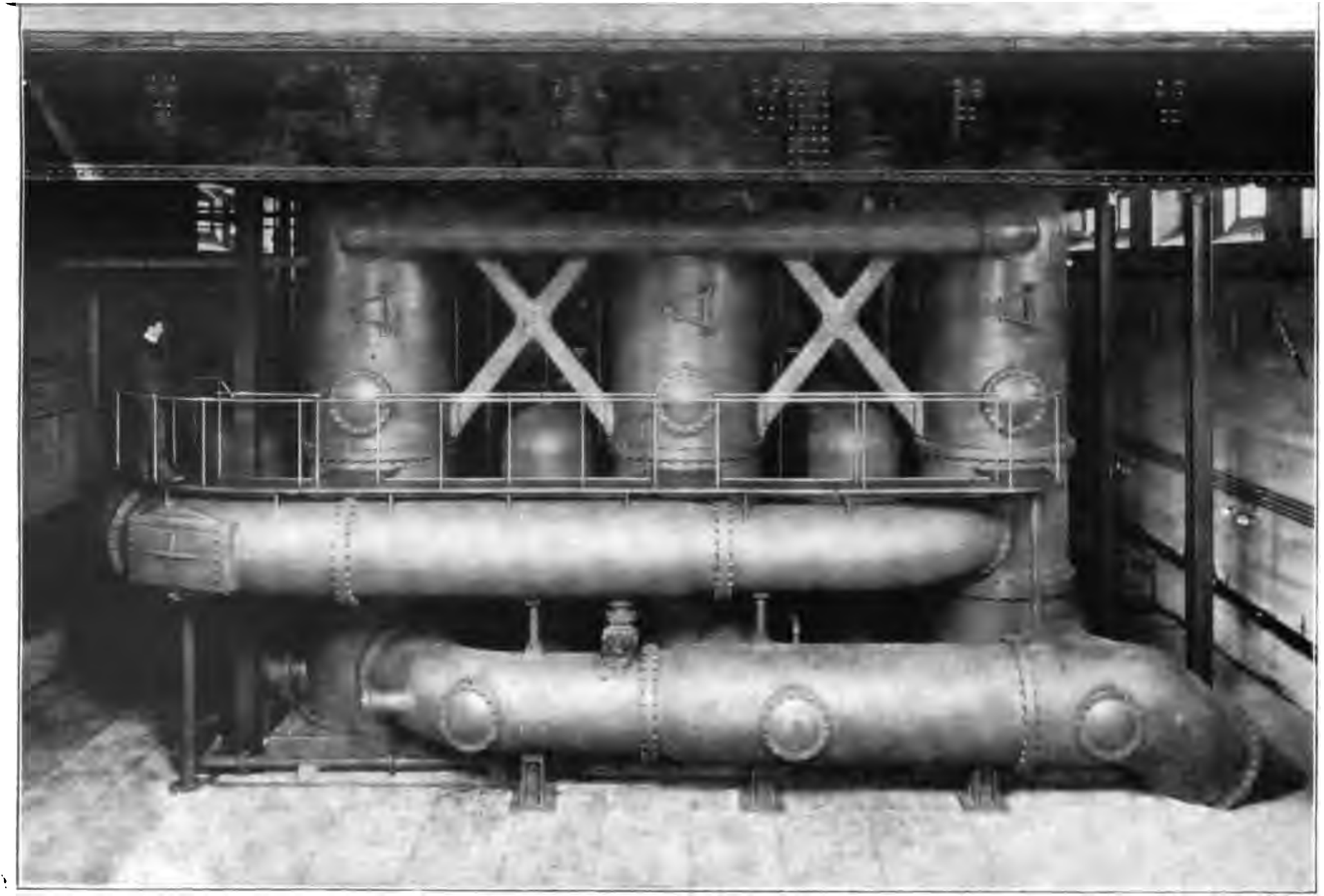
MAINTENANCE.

Scope of Work and Force Employed.

The maintenance of the Metropolitan Sewerage systems includes the operation of seven stations and 95.5 miles of Metropolitan sewers, receiving the discharge from 964.5 miles of town and city sewers at 298 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 115 men includes 65 engineers and other employés at the pumping stations, and 50 men employed on actual sewer maintenance and care of pumping station grounds. In the three following tables the use of the completed systems and other data are shown: —





PUMPING ENGINE (SHOWING BOTH ENGINE AND PUMPS) AT WARD STREET PUMPING STATION.

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations of December 31, 1904.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by each House-connection.*	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
Boston (Deer Island), .	0.70	Separate, ...	-	-	1,600†	1,600	-	-	100.0	-
Winthrop, ...	26.80	Separate, ...	1,706	4.6	7,848	8,000	1.23	1.61	98.1	76.4
Boston (East Boston), .	21.11	Separate and combined,	5,106	8.9	45,443	48,800	0.75	2.18	93.1	34.4
Chelsea, ...	13.12‡	Combined, . . .	1,380	7.2	9,936	38,400	0.68	2.24	25.8	30.4
Everett, ...	40.74	Separate and combined,	3,715	6.3	23,404	30,100	1.77	3.34	77.8	53.0
Malden, ...	47.47	Separate, ...	4,202	6.3	26,473	42,000	2.54	5.07	63.0	50.1
Melrose, ...	32.57	Separate, ...	2,277	4.4	10,018	14,700	1.60	3.73	68.2	42.9
Boston (Charlestown), .	21.08	Separate and combined,	5,086	7.9	40,179§	41,000	0.67	1.27	98.0	52.8
Cambridge, ...	117.58	Separate and combined,	14,386	7.0	100,702	102,200	4.94	6.11	98.5	80.9
Somerville, ...	84.60	Separate and combined,	12,784	5.5	70,312	71,700	3.27	3.96	98.0	82.6
Medford, ...	48.39	Separate, ...	3,116	6.4	19,942	22,700	2.48	8.35	87.8	29.7
Winchester, ...	20.82	Separate, ...	879	5.6	4,922	8,600	1.05	5.95	57.2	17.6
Woburn, ...	12.34‖	Separate, ...	875	5.9	5,162	15,400	0.89	12.71	33.5	7.0
Stoneham, ...	10.94	Separate, ...	497	4.5	2,237	6,500	0.59	5.50	34.4	10.7
Arlington, ...	19.18	Separate, ...	864	6.6	5,702	10,400	1.68	5.20	54.8	31.3
Belmont, ...	8.66	Separate, ...	270	7.6	2,497¶	5,200	0.89	4.66	48.0	19.1
Wakefield, ...	10.80	Separate, ...	285	5.6	1,596	10,500	0.40	7.65	15.2	5.2
Lexington,**	-	- -	-	-	-	2,800	-	5.11	-	-
Revere, ...	21.28	Separate, ...	1,559	6.0	9,354	13,900	1.31	5.86	67.3	22.4
Totals, . . .	558.18	- -	58,987	6.6	387,327	494,500	26.69	90.50	78.3	29.5

* Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1900 extended to 1904.
† Estimated by Superintendent J. R. Gerrish of the Institution on Deer Island.
‡ The Pearl Street district of Chelsea temporarily excluded, owing to connection not being properly maintained.
§ Including 30 persons at Navy Yard.
‖ Exclusive of Mystic River valley sewer and tanneries.
¶ Including 2 connections with McLean Hospital, having an estimated population of 445.
** Lexington not connected.

South Metropolitan System.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations of December 31, 1904.]

Cities and Towns.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by each House-connection.*	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
Boston (Back Bay),	21.97	Separate and combined,	1,464	15.8	23,181	24,400	1.20	1.61	94.8	74.5
Boston (Brighton),	53.12	Separate and combined,	2,519	5.9	14,862	24,400	3.16	3.74	60.9	84.5
Brookline,	56.67	Separate and combined,	2,958	7.0	20,706	25,100	3.24	6.81	82.5	47.6
Newton,	99.00	Separate,	4,932	6.3	31,072	39,900	6.77	16.88	77.9	40.1
Watertown,	31.30	Separate,	1,574	5.3	8,342	11,500	1.78	4.04	72.5	44.1
Waltham,	38.53	Separate,	2,686	8.9†	23,905	27,600	2.41	13.63	86.6	17.7
Boston (Dorchester),	15.61	Separate and combined,	1,166	6.8	7,929	46,600	0.90	4.89	17.0	18.4
Milton,	6.19	Separate and combined,	94	6.0	564	7,900	0.35	12.59	7.1	2.8
Hyde Park,	18.68	Separate,	799	7.9†	6,312	14,700	0.99	4.57	42.9	21.7
Dedham,	14.11	Separate,	238	5.0	1,190	7,400	0.71	9.40	16.1	7.6
Boston (Roxbury),	-	-	-	-	-	31,300	-	1.23	-	-
Boston (West Roxbury),	5.62	Separate,	188	7.2	1,354	29,100	0.32	8.92	4.7	3.6
Quincy,	45.52	Separate,	1,499	5.6	8,394	28,400	2.27	12.56	29.6	18.1
Totals,	406.32	-	20,117	7.3	147,761	318,300	24.10	100.87	46.4	23.9

* Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1900 extended to 1904.

† Estimated by City Engineer.

Whole Metropolitan System.

Table showing Areas delivering Sewage to the Entire System, inclusive of added High-level Area; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations of December 31, 1904.]

System.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by each House-connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
North Metropolitan, .	558.18	Separate and combined,	58,987	6.6	387,327	494,500	26.69	90.50	78.3	29.5
South Metropolitan, .	406.32	Separate and combined,	20,117	7.3	147,761	318,300	24.10	100.87	46.4	23.9
Totals, . . .	964.50	- -	79,104	6.8	535,088	812,800	50.79	191.37	65.8	26.5

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan stations : —

North Metropolitan System.

Deer Island Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 45,900,000 foot-pounds.
Average quantity raised each day: 57,200,000 gallons.
Force employed: 3 engineers, 3 firemen, 6 screenmen and 1 reliefman.
Coal used: first-quality Cumberland, costing from $3.45 to $3.90 per ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1904.						
January,	1,603,900,000	51,700,000	40,600,000	90,400,000	10.74	44,000,000
February,	1,630,100,000	56,200,000	46,200,000	87,300,000	10.83	45,000,000
March,	2,462,700,000	79,400,000	61,100,000	124,800,000	11.72	51,900,000
April,	2,407,400,000	80,200,000	52,600,000	145,000,000	11.77	57,100,000
May,	2,458,800,000	79,300,000	60,600,000	119,200,000	11.66	57,800,000
June,	1,624,500,000	54,200,000	43,100,000	72,400,000	10.55	44,700,000
July,	1,492,900,000	48,200,000	40,800,000	58,100,000	10.60	41,200,000
August,	1,364,400,000	44,000,000	36,600,000	57,800,000	10.11	41,200,000
September,	1,423,600,000	47,500,000	37,300,000	89,800,000	10.10	42,500,000
October,	1,390,700,000	44,900,000	37,800,000	65,300,000	10.21	41,300,000
November,	1,447,600,000	48,300,000	42,600,000	74,600,000	10.50	40,900,000
December,	1,613,400,000	52,000,000	44,900,000	92,700,000	10.84	43,600,000
Total,	20,920,000,000	-	-	-	-	-
Average,	-	57,200,000	45,300,000	89,800,000	10.81	45,900,000

East Boston Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 56,000,000 foot-pounds.
Average quantity raised each day: 55,000,000 gallons.
Force employed: 3 engineers, 3 firemen, 6 screenmen and 1 reliefman.
Coal used: first-quality Cumberland, costing from $3.30 to $3.90 per ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1904.						
January,	1,541,900,000	49,700,000	38,600,000	88,400,000	15.19	52,600,000
February,	1,572,100,000	54,200,000	44,200,000	85,300,000	15.31	50,500,000
March,	2,400,700,000	77,400,000	59,100,000	122,800,000	15.51	58,800,000
April,	2,347,400,000	78,200,000	50,600,000	143,000,000	15.53	61,100,000
May,	2,396,800,000	77,300,000	58,600,000	117,200,000	15.57	60,500,000
June,	1,564,500,000	52,200,000	41,100,000	70,400,000	15.27	57,200,000
July,	1,375,900,000	44,400,000	37,800,000	53,100,000	15.17	54,400,000
August,	1,297,400,000	41,900,000	34,600,000	55,800,000	15.26	56,600,000
September,	1,363,600,000	45,500,000	35,300,000	87,800,000	16.13	55,300,000
October,	1,328,700,000	42,900,000	35,300,000	63,300,000	16.14	55,100,000
November,	1,387,600,000	46,300,000	40,600,000	72,600,000	16.29	56,200,000
December,	1,551,400,000	50,000,000	42,900,000	90,700,000	16.34	53,100,000
Total,	20,128,000,000	-	-	-	-	-
Average,	-	55,000,000	43,200,000	87,500,000	15.64	56,000,000

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.
Average duty for the year: 43,200,000 foot-pounds.
Average quantity raised each day: 31,100,000 gallons.
Force employed: 3 engineers, 3 firemen, 6 screenmen and 1 reliefman.
Coal used: first quality Cumberland, costing from $3.45 to $4.38 per ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1904.						
January,	1,000,600,000	32,300,000	26,600,000	48,600,000	8.05	40,900,000
February,	966,100,000	33,300,000	28,300,000	49,300,000	8.07	42,100,000
March,	1,198,800,000	38,700,000	31,300,000	57,900,000	8.43	51,100,000
April,	1,161,000,000	38,700,000	29,200,000	64,000,000	8.48	52,900,000
May,	1,171,000,000	37,800,000	31,300,000	51,800,000	8.38	53,900,000
June,	875,800,000	29,200,000	24,500,000	34,500,000	7.84	39,600,000
July,	865,000,000	27,900,000	24,200,000	34,400,000	7.77	39,000,000
August,	858,700,000	27,700,000	24,200,000	36,200,000	7.72	41,200,000
September,	842,000,000	28,100,000	22,800,000	49,000,000	7.75	42,300,000
October,	765,500,000	24,700,000	20,800,000	34,400,000	7.97	36,900,000
November,	786,800,000	26,200,000	23,200,000	39,300,000	7.81	39,200,000
December,	902,700,000	29,100,000	24,200,000	46,700,000	7.85	39,800,000
Total,	11,394,000,000	-	-	-	-	-
Average,	-	31,100,000	25,900,000	45,500,000	8.01	43,200,000

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consist of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.
Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.
Average duty for the year: 17,900,000 foot-pounds.
Average quantity raised each day: 3,546,000 gallons.
Force employed: 3 engineers.
Coal used: first quality Cumberland, costing from $3.71 to $4.73 per ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1904.						
January,	110,062,000	3,550,000	2,692,000	7,167,000	12.96	18,200,000
February,	116,379,000	4,013,000	2,881,000	7,580,000	12.98	20,400,000
March,	183,565,000	5,921,000	3,968,000	8,996,000	12.49	24,400,000
April,	156,351,000	5,212,000	3,788,000	9,173,000	12.41	22,200,000
May,	158,906,000	5,126,000	3,380,000	7,875,000	12.45	22,100,000
June,	101,217,000	3,374,000	2,598,000	4,677,000	12.83	16,600,000
July,	84,397,000	2,723,000	1,994,000	4,027,000	13.15	16,100,000
August,	69,408,000	2,239,000	1,545,000	3,526,000	13.25	13,800,000
September,	81,272,000	2,709,000	1,616,000	6,400,000	13.25	15,800,000
October,	74,171,000	2,393,000	1,868,000	3,574,000	13.23	14,300,000
November,	74,625,000	2,487,000	2,120,000	4,554,000	13.25	14,600,000
December,	86,766,000	2,799,000	2,414,000	6,835,000	13.29	15,900,000
Total,	1,297,119,000	-	-	-	-	-
Average,	-	3,546,000	2,572,000	6,157,000	12.96	17,900,000

South Metropolitan System.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines.

Contract capacity of pumps: one, 3,000,000 gallons, the other, 5,000,000 gallons, with 36-foot lift.
Average duty for the year: 36,400,000 foot-pounds.
Average quantity raised each day: 3,651,000 gallons.
Force employed: 3 engineers and 1 screenman.
Coal used: first-quality Cumberland, costing from $4.20 to $5.04 per ton.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1904.						
January,	81,296,000	2,622,000	2,291,000	3,182,000	36.32	29,900,000
February,	98,621,000	3,401,000	2,591,000	5,427,000	37.73	35,500,000
March,	177,415,000	5,723,000	4,675,000	8,391,000	36.12	40,500,000
April,	161,500,000	5,383,000	4,608,000	8,367,000	36.62	43,200,000
May,	185,903,000	5,997,000	5,080,000	7,654,000	39.25	43,500,000
June,	131,342,000	4,378,000	2,900,000	5,227,000	33.84	42,200,000
July,	96,760,000	3,121,000	2,480,000	4,419,000	36.10	35,900,000
August,	80,158,000	2,586,000	2,347,000	3,157,000	36.50	34,200,000
September,	80,270,000	2,675,000	2,225,000	3,882,000	35.90	34,200,000
October,	80,113,000	2,584,000	2,396,000	3,527,000	36.19	32,800,000
November,	84,070,000	2,712,000	2,533,000	3,605,000	36.04	32,500,000
December,	81,367,000	2,625,000	2,059,000	3,132,000	37.72	32,900,000
Total,	1,338,810,000	-	-	-	-	-
Average,	-	3,651,000	3,015,000	4,998,000	36.53	36,400,000

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.
Average quantity raised each day from October 14, 1904 to December 31, 1904: 12,700,000 gallons.

Table of Approximate Quantities at the Ward Street Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).
1904.				
October,*	183,900,000	10,200,000	6,900,000	13,500,000
November,	406,700,000	13,600,000	7,900,000	27,500,000
December,	412,300,000	13,300,000	10,800,000	23,100,000
Total,	1,002,900,000	-	-	-
Average,	-	12,700,000	8,500,000	21,400,000

* From October 14 only.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of five pumping stations are shown in detail: —

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (20,920 Million Gallons)×Lift (10.81 Feet)=226,145 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$11,368 51	$0.05027
Coal,	7,330 20	.03241
Oil,	192 02	.00085
Waste,	74 47	.00033
Water,	1,209 60	.00535
Packing,	72 30	.00032
Miscellaneous supplies and renewals,	916 44	.00405
Totals,	$21,163 54	$0.09358

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (20,128 Million Gallons) × Lift (15.64 Feet) = 314,802 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$10,550 24	$0.03351
Coal,	7,997 52	.02540
Oil,	253 77	.00081
Waste,	55 77	.00018
Water,	940 80	.00299
Packing,	11 78	.00004
Miscellaneous supplies and renewals,	536 89	.00171
Totals,	$20,346 77	$0.06464

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (11,394 Million Gallons) × Lift (8.01 Feet) = 91,266 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$9,985 88	$0.10942
Coal,	3,156 35	.03458
Oil,	171 30	.00188
Waste,	70 49	.00077
Water,	410 40	.00449
Packing,	76 77	.00084
Miscellaneous supplies and renewals,	669 51	.00734
Totals,	$14,540 70	$0.15932

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,297.119 Million Gallons) × Lift (12.96 Feet) = 16,811 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$3,377 09	$0.20089
Coal,	1,630 38	.09698
Oil,	110 91	.00659
Waste,	40 57	.00241
Water,	242 40	.01442
Packing,	19 77	.00118
Miscellaneous supplies and renewals,	447 76	.02664
Totals,	$5,868 88	$0.34911

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,338.81 Million Gallons) × Lift (36.53 Feet) = 48,907 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$3,888 97	$0.07952
Coal,	2,583 85	.05283
Oil,	26 95	.00055
Waste,	10 43	.00021
Water,	201 86	.00413
Packing,	39 84	.00082
Miscellaneous supplies and renewals,	633 15	.01294
Totals,	$7,385 05	$0.15100

Material Intercepted at the Screens.

The sewage of the North Metropolitan District, on entering the three main line pumping stations and before reaching the pumps, is screened through cages, provided in duplicate, and raised or lowered by steam power. This intercepted material consists of rags, paper and other floating matter, and amounted to a total of about 2,084 cubic yards during the year. This is equivalent to about 2.7 cubic feet for each million gallons of sewage pumped at Deer Island.

Care of Special Structures.

During the year the wharf at Deer Island has been reinforced with 50 new oak piles, and some of the stringers and a portion of the planking have also been renewed. The cast-iron water piping in the grounds about the pumping station has been extended during the year to improve the fire protection at the dwelling house and lockers, involving the placing of about 1,000 feet of 4-inch and 6-inch pipe and 2 hydrants. About 400 tons of riprap have been deposited on Deer Island bar over the line of the outfall sewer.

Heavy riprap has been placed on the earth slopes about the shore structures at both ends of the Malden River siphon, and the embankment over the sewer across the marsh on the Everett side of the siphon has been repaired. This work has involved the placing of 500 tons of stone.

The sewage flow in the old Mystic valley sewer in Winchester has at times surcharged the sewer, so that it has been found desirable to connect the Cummingsville branch, Section 47, with the low-level sewer, Section 44, built in 1893. This connection was made by the maintenance force during the year. About 130 feet of 18-inch Akron pipe, reinforced with concrete, were laid at an average depth of 10 feet from near the junction of Lake and Main streets, through Lake Street, to the lower end of the siphon under the Wedge Pond culvert. The siphon is thus abandoned and a free outlet at a lower level obtained for the Cummingsville branch, thereby to a great extent relieving the old Mystic valley sewer.

Studies of sewage flow in the Metropolitan sewers, siphons and outfall pipes indicate freedom from deposits and satisfactory conditions in general.

FUTURE EXTENSION OF THE METROPOLITAN SEWER INTO THE HIGHER TERRITORY OF BROOKLINE, BRIGHTON AND NEWTON.

The Board was directed, by chapter 230 of the legislative Acts of 1904, "to determine the location, elevation and size of the Metropolitan High-level Sewer above the point where the sewage from the Charles River valley is to be received."

South Metropolitan System.

Chapter 424 of the legislative Acts of 1899 constituted the South Metropolitan System by combining the original Charles River Metropolitan district, the original Neponset valley Metropolitan district, the city of Quincy, and parts of the Dorchester, Roxbury and West Roxbury districts of the city of Boston. The system as at present constituted provides for the drainage of 102 square miles of Metropolitan territory in Suffolk, Norfolk and Middlesex counties, and includes the whole or parts of 9 cities and towns, having a present population of 318,000, as set forth in the following table, and outlined on the general map accompanying this report: —

Table No. 1. — *Showing Areas and Populations in South Metropolitan District December 31, 1904.*

City or Town.	Area (Square Miles).	Population, December 31, 1904.
Boston (portions of),	20.92	155,800
Brookline,	6.81	25,100
Dedham,*	9.40	7,400
Hyde Park,	4.57	14,700
Milton,	12.59	7,900
Newton,	18.03	39,900
Quincy,	12.56	28,400
Waltham,	13.63	27,600
Watertown,	4.04	11,500
Totals,	102.55	318,300

* Part of town.

The higher portions of this district, embracing an area of 64 square miles, with a present population of 179,000, are at sufficient elevation to permit their sewage to be collected in a trunk sewer and conveyed by gravity to an outlet in the harbor. The sewage from the 39 square miles of lower territory, with a present population of 139,000, will always need to be pumped. This division of the South Metropolitan territory into high-level and low-level sections is outlined on the general map and set forth in the following tables: —

TABLE No. 2. — *Showing Area of South Metropolitan District that may be drained by Gravity, with Estimated Population December 31, 1904.*

City or Town.	Area (Square Miles).	Population, December 31, 1904.
Boston,	15.09	108,400
Brookline,	5.49	18,100
Dedham,*	9.40	7,400
Hyde Park,	4.57	14,700
Milton,	11.50	7,200
Newton,	13.35	25,700
Quincy,	4.30	8,000
Totals,	63.70	179,500

* Part of town.

TABLE No. 3. — *Showing Area of South Metropolitan District the Sewage from which will require Pumping, with Estimated Population December 31, 1904.*

City or Town.	Area (Square Miles).	Population, December 31, 1904.
Boston,	5.83	52,400
Brookline,	1.32	12,000
Milton,	1.09	700
Newton,	4.68	14,200
Quincy,	8.26	20,400
Waltham,	13.68	27,600
Watertown,	4.04	11,500
Totals,	38.85	138,800

The High-level Sewer.

Chapter 424 of the Acts of 1899 further authorized the construction and operation of a main sewer and appurtenances, known as the High-level Sewer, for the disposal of sewage from this South Metropolitan area by gravity. This trunk sewer has been under construction for the past four years, and has but recently been completed and put into operation. It is designed to receive and carry by gravity the sewage from the 64 square miles of high-level territory outlined in Table No. 2. Sewage from the original Charles River district is at present lifted to it by pumps at a station on Ward Street in Roxbury. The sewage of parts of the city of Quincy will be pumped to it at a station in Merrymount Park in that city. A small district of about 2 square miles, from which sewage may eventually be raised to the High-level Sewer, includes portions of Dorchester and Milton, extending from Hyde Park to Granite Bridge. It is at present tributary to the lower portion of the original Neponset valley Metropolitan sewer, and will probably continue to discharge into the Boston Main Drainage Works for some years.

The High-level Sewer, so far as authorized by legislative acts and already constructed and in operation, has a length of about 17 miles, extending from the Ward Street pumping station in Roxbury to an outlet in the outer harbor a mile below Nut Island in Quincy. The outfall works involve two lines of 60-inch cast-iron pipe laid below the bed of the harbor, from the outlet to Nut Island. A screen-house, sand-catcher and gate-chamber for regulating the sewage flow are located on the island. At this point the sewer is about 11 feet wide and 12 feet high. Its invert, by the Metropolitan Sewerage base, which is 100 feet below the city of Boston base, is at elevation 110, or mean high water of the harbor. It extends through Quincy, follows along Unkety and Pine Tree Brook valleys in Milton to Hyde Park, thence passing through the Neponset-Stony Brook divide, along the westerly side of the Stony Brook valley to near the easterly side of Jamaica Pond, at the junction of Perkins and Centre streets in Jamaica Plain, where a branch has been left for future extension of the works into the higher territory of Brookline, Brighton and Newton. At this point it is about 9 feet in diameter, and its invert elevation is about

131.5 feet, or 21.5 feet above mean high water of the harbor. From here the sewer is 6 feet 6 inches wide and 7 feet high, and extends northerly through Parker Hill to near the junction of St. Alphonsus and Smith streets in Roxbury, connecting with two 48-inch force mains from the Ward Street pumping station, which convey to it the sewage from the original Charles River main sewer. A detailed description of this construction is given in the eleventh and twelfth reports of the Metropolitan Sewerage Commission and the first to fourth reports of the Metropolitan Water and Sewerage Board.

Present Need of defining Location for Extension of High-level Sewer.

Section 8 of chapter 424 of the Acts of 1899 provides that only separate sewage from new districts shall be received into the High-level Sewer. Chapter 383 of the Acts of 1903 requires that "Any city or town using any metropolitan sewer may, in any year, and shall in any year specified by the officer or board having charge of said sewers, expend one-twentieth of one per cent. of its taxable valuation, to be met by loan outside the debt limit, in the construction, in connection with said sewers, of branch intercepting sewers, connections of existing sewers with intercepting sewers, branch drains, sewers or drains in any street where one thereof only shall have been built, and the necessary connections aforesaid." Chapter 465 of the Acts of 1903 provides for a park basin in the Charles River valley above Craigie Bridge. All these facts foreshadow an early construction of separate systems of sewerage by municipalities of the South Metropolitan District which at present have combined sewers.

The town of Brookline and the Back Bay, Brighton, Roxbury, West Roxbury and Dorchester districts of the city of Boston are now largely sewered on the combined system. To proceed intelligently with the design for separate systems of sewerage for these districts requires detailed information relating to the future extension of the High-level Sewer. Studies to develop this information are authorized by the recent legislative action (chapter 230, Acts of 1904), directing the Board to define the location and size of this extension.

District Involved in Study for Extension of the High-level Sewer.

Metropolitan areas that may be traversed by this extension are set forth in the following table: —

TABLE No. 4. — *Showing Areas Involved in Study for Extension of the High-level Sewer above Jamaica Plain.*

City or Town.	Area (Square Miles).	City or Town.	Area (Square Miles).
Boston: —		Newton,	18.03
Back Bay district,	1.61	Waltham,	13.63
Brighton district,	4.27	Watertown,	4.04
West Roxbury (part of),	0.18	Total,	48.57
Brookline,	6.81		

Anticipated Volume of Sewage.

To determine the size for the extension of this sewer through the territory set forth above involves certain approximations of the volume of sewage to be anticipated in future years. In public works of this character provision is usually made for a generation. The High-level Sewer already constructed was intended to provide for anticipated conditions in the year 1940, and it would seem proper to provide for this extension to the same date. Sewage which reaches an intercepting sewer of this character is made up largely of public and private water supplies, leakage of ground water into the sewer, and a small amount of surface water. It is usual to estimate its volume by a per capita rate.

Population.

Several forecasts of population on Metropolitan areas have been prepared by the engineers of the Metropolitan Water Board, Metropolitan Sewerage Commission and State Board of Health. There is a substantial agreement in all these forecasts, and the populations adopted for this study and set forth in the following table are as liberal as any that have been suggested.

TABLE No. 5. — *Forecasts of Populations for Areas Involved in Studies for the Extension of the High-level Sewer above Jamaica Plain, from A.D. 1905 to 1940.*

City or Town.	Estimated Populations.							
	1905.	1910.	1915.	1920.	1925.	1930.	1935.	1940.
Boston: —								
Back Bay district,	24,400	28,000	31,000	34,500	39,000	45,000	52,000	60,000
Brighton district,	24,400	31,000	38,200	47,100	57,100	68,000	80,000	93,000
West Roxbury (part of),	350	550	850	1,250	1,700	2,200	2,800	3,500
Brookline,	25,100	32,500	41,000	50,000	61,000	73,000	86,000	101,000
Newton,	39,900	52,500	66,000	80,000	95,000	111,000	127,000	144,000
Waltham,	27,600	34,000	40,800	49,000	58,800	69,000	79,000	89,000
Watertown,	11,500	14,500	17,500	21,000	25,500	30,500	36,000	42,000
Totals,	153,250	193,050	235,350	282,850	338,100	398,700	462,800	532,500

A subdivision of these populations has been prepared, indicating what may be anticipated on areas drained by gravity, and what may be assumed to be permanently tributary to the low-level system, as set forth in the following table: —

TABLE NO. 6. — *Population in High-level and Low-level Areas Involved in Studies for the Extension of the High-level Sewer above Jamaica Plain, from A.D. 1905 to 1940.*

[Parts of Brookline and Newton are permanently tributary to the Neponset valley and existing High-level Sewer, and anticipated populations in such areas are not included in this table.]

City or Town.	Estimated Populations.															
	1905.		1910.		1915.		1920.		1925.		1930.		1935.		1940.	
	High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.	High Level	Low Level.	High Level.	Low Level.
Boston: —																
Back Bay District, . .	-	24,400	-	28,000	-	31,000	-	34,500	-	39,000	-	45,000	-	52,000	-	60,000
Brighton, ...	7,500	16,900	9,500	21,500	11,600	26,600	14,500	32,600	17,500	39,600	20,500	47,500	24,000	56,000	27,500	65,500
West Roxbury (part of),	350	-	550	-	850	-	1,250	-	1,700	-	2,200	-	2,800	-	3,500	-
Brookline, ...	12,300	12,000	17,000	14,000	22,500	16,000	28,000	18,500	35,000	21,500	42,000	25,000	50,000	28,500	58,500	33,000
Newton, ...	25,200	14,200	33,500	18,000	41,500	22,500	50,000	27,000	58,500	32,000	68,000	37,000	77,500	42,500	88,000	48,000
Waltham, ...	-	27,600	-	34,000	-	40,800	-	49,000	-	58,800	-	69,000	-	79,000	-	89,000
Watertown, ...	-	11,500	-	14,500	-	17,500	-	21,000	-	25,500	-	30,500	-	36,000	-	42,000
Total high level, . .	45,350	-	60,550	-	76,450	-	93,750	-	112,700	-	132,700	-	154,300	-	177,500	-
Total low level, . .	-	106,600	-	130,000	-	154,400	-	182,600	-	216,400	-	254,000	-	294,000	-	337,500

From this table it appears that the total present population on areas tributary by gravity to an extension of the High-level Sewer may be 45,350, and that in 1940 it may have increased to 177,500; and that the present population on the low-level pumped area may be 106,600, and in 1940 may have increased to 337,500.

Per Capita Rate to be used in Determining Size of Sewer.

The amount of sewage per capita to be provided for in the earlier years in the district under discussion may be judged practically from the Boston Main Drainage and the Metropolitan Sewerage Works, which have both been in operation many years. The latter receives sewage from areas sewered about equally on the separate and combined systems, not unlike the present condition of the territory to be traversed by the proposed extension of the High-level Sewer. In 1898 an extended study was prepared by the Engineer of the Metropolitan Sewerage Works, involving a comprehensive review of volumes of sewage from both works. Per capita rates deduced from that study and adopted for the High-level Sewer already built, designed ultimately to receive sewage from separate sewers only, are as follows: —

	1905.	1940.
Yearly average flow of sewage,	147	175
Maximum dry weather flow,	165	200
Maximum flow during storms,	251	300

Studies of sewage flows in Metropolitan sewers since 1898 indicate that the above conclusions from earlier studies are fully justified.

This extension of the High-level Sewer above Jamaica Plain is to receive sewage from cities and towns that are now or in the near future probably will be sewered on the separate system, from which practically all surface waters will be excluded. The present water supply of many of these cities and towns is comparatively small, not more than one-half of the average water supply of the whole Metropolitan District which was involved in establishing the above rates, so that 300 gallons per capita might appear unnecessarily liberal for fixing the size of this extension. Some of the municipalities, however, are already provided with separate sewers designed

on a rate exceeding 200 gallons per capita when running full, and many of these local sewers are now occasionally surcharged. This sewer will be located at considerable distance inland from the Charles River, so that occasional overflows into the river cannot be provided to relieve any future lack of capacity. It is also possible that in the future a larger area and population than now studied may be made tributary to this extension.

The increased sizes of sewer resulting from this liberal rate per capita will add but a small percentage to the cost of the work. There is a persistent increase in water consumption in the whole Metropolitan District. Population is advancing at phenomenal and unanticipated rates, particularly in the outlying sections to be traversed by this extension, and all experience gained from the operation of the Metropolitan Works dictates the most liberal treatment for extensions into outlying territory. The rates already adopted for the earlier high-level construction and set forth above are therefore felt to be justified for this extension and have been adopted in this study.

The volume of sewage estimated from the before-mentioned rates of flow per capita and the population given in the tables is set forth in Table No. 7 : —

TABLE NO. 7. — *Showing Daily Volume of Sewage Anticipated from High and Low Level Territory Involved in Study for Extension of High-level Sewer above Jamaica Plain, from 1905 to 1940.*

[In Gallons.]

CITY OR TOWN.	1905.						1910.					
	HIGH LEVEL.			LOW LEVEL.			HIGH LEVEL.			LOW LEVEL.		
	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.
Boston: —												
Back Bay district,	-	-	-	3,587,000	4,026,000	6,124,000	-	-	-	4,228,000	4,760,000	7,224,000
Brighton,	1,102,000	1,237,000	1,882,000	2,484,000	2,789,000	4,242,000	1,434,000	1,615,000	2,451,000	3,246,000	3,655,000	5,547,000
West Roxbury (part of),	51,000	58,000	88,000	-	-	-	83,000	94,000	142,000	-	-	-
Brookline,	1,808,000	2,030,000	3,087,000	1,764,000	1,980,000	3,012,000	2,567,000	2,890,000	4,386,000	2,114,000	2,380,000	3,612,000
Newton,	3,704,000	4,158,000	6,325,000	2,087,000	2,343,000	3,564,000	5,058,000	5,695,000	8,643,000	2,718,000	3,060,000	4,644,000
Waltham,	-	-	-	4,057,000	4,554,000	6,928,000	-	-	-	5,134,000	5,780,000	8,772,000
Watertown,	-	-	-	1,691,000	1,898,000	2,887,000	-	-	-	2,189,000	2,465,000	3,741,000
Total high level,	6,665,000	7,483,000	11,382,000	-	-	-	9,142,000	10,294,000	15,622,000	-	-	-
Total low level,	-	-	-	15,670,000	17,590,000	26,757,000	-	-	-	19,629,000	22,100,000	33,540,000

TABLE NO. 7. — *Showing Daily Volume of Sewage Anticipated, etc.* — Continued.

[In Gallons.]

CITY OR TOWN.	1915.						1920.					
	HIGH LEVEL.			LOW LEVEL.			HIGH LEVEL.			LOW LEVEL.		
	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.
Boston: —												
Back Bay district, . .	-	-	-	4,805,000	5,425,000	8,215,000	-	-	-	5,485,000	6,210,000	9,384,000
Brighton, ...	1,798,000	2,030,000	3,074,000	4,123,000	4,655,000	7,049,000	2,305,000	2,610,000	3,944,000	5,183,000	5,868,000	8,867,000
West Roxbury (part of),	132,000	149,000	225,000	-	-	-	199,000	225,000	340,000	-	-	-
Brookline, ...	3,487,000	3,987,000	5,962,000	2,480,000	2,800,000	4,240,000	4,452,000	5,040,000	7,616,000	2,942,000	3,330,000	5,032,000
Newton, ...	6,433,000	7,262,000	10,997,000	3,487,000	3,937,000	5,962,000	7,950,000	9,000,000	13,600,000	4,293,000	4,860,000	7,344,000
Waltham, ...	-	-	-	6,324,000	7,140,000	10,812,000	-	-	-	7,791,000	8,820,000	13,328,000
Watertown, ...	-	-	-	2,712,000	3,062,000	4,638,000	-	-	-	3,339,000	3,780,000	5,712,000
Total high level, . .	11,850,000	13,378,000	20,258,000	-	-	-	14,906,000	16,875,000	25,500,000	-	-	-
Total low level, . .	-	-	-	23,931,000	27,019,000	40,916,000	-	-	-	29,033,000	32,868,000	49,667,000

TABLE No. 7. — *Showing Daily Volume of Sewage Anticipated, etc.* — Continued.

[In Gallons.]

City or Town.	1925.						1930.					
	High Level.			Low Level.			High Level.			Low Level.		
	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.	Average Daily Flow.	Maximum Dry Weather Flow.	Maximum Storm Flow.
Boston: —												
Back Bay district, . .	-	-	-	6,357,000	7,215,000	10,881,000	-	-	-	7,515,000	8,550,000	12,870,000
Brighton, ...	2,858,000	3,238,000	4,883,000	6,454,000	7,326,000	11,048,000	3,424,000	3,895,000	5,863,000	7,932,000	9,025,000	13,585,000
West Roxbury (part of),	277,000	314,000	475,000	-	-	-	367,000	418,000	629,000	-	-	-
Brookline, ...	5,705,000	6,475,000	9,765,000	3,504,000	3,977,000	6,000,000	7,014,000	7,980,000	12,012,000	4,175,000	4,750,000	7,150,000
Newton, ...	9,535,000	10,822,000	16,321,000	5,216,000	5,920,000	8,928,000	11,356,000	12,920,000	19,448,000	6,179,000	7,030,000	10,582,000
Waltham, ...	-	-	-	9,584,000	10,878,000	16,405,000	-	-	-	11,523,000	13,110,000	19,734,000
Watertown, ...	-	-	-	4,156,000	4,717,000	7,114,000	-	-	-	5,094,000	5,795,000	8,723,000
Total high level, . .	18,370,000	20,849,000	31,444,000	-	-	-	22,161,000	25,213,000	37,952,000	-	-	-
Total low level, . .	-	-	-	35,271,000	40,033,000	60,376,000	-	-	-	42,418,000	48,260,000	72,644,000

TABLE No. 7. — *Showing Daily Volume of Sewage Anticipated, etc.* — Concluded.

[In Gallons.]

City or Town.	1935. High Level. Average Daily Flow.	1935. High Level. Maximum Dry Weather Flow.	1935. High Level. Maximum Storm Flow.	1935. Low Level. Average Daily Flow.	1935. Low Level. Maximum Dry Weather Flow.	1935. Low Level. Maximum Storm Flow.	1940. High Level. Average Daily Flow.	1940. High Level. Maximum Dry Weather Flow.	1940. High Level. Maximum Storm Flow.	1940. Low Level. Average Daily Flow.	1940. Low Level. Maximum Dry Weather Flow.	1940. Low Level. Maximum Storm Flow.
Boston: —												
Back Bay District, . .	-	-	-	8,892,000	10,140,000	15,236,000	-	-	-	10,500,000	12,000,000	18,000,000
Brighton, ...	4,104,000	4,680,000	7,032,000	9,576,000	10,920,000	16,408,000	4,813,000	5,500,000	8,250,000	11,463,000	13,100,000	19,650,000
West Roxbury (part of),	479,000	546,000	820,000	-	-	-	613,000	700,000	1,050,000	-	-	-
Brookline, ...	8,550,000	9,750,000	14,650,000	4,874,000	5,557,000	8,351,000	10,237,000	11,700,000	17,550,000	5,775,000	6,600,000	9,900,000
Newton, ...	13,252,000	15,112,000	22,707,000	7,267,000	8,287,000	12,452,000	15,400,000	17,600,000	26,400,000	8,400,000	9,600,000	14,400,000
Waltham, ...	-	-	-	13,509,000	15,405,000	23,147,000	-	-	-	15,575,000	17,800,000	26,700,000
Watertown, ...	-	-	-	6,156,000	7,020,000	10,548,000	-	-	-	7,350,000	8,400,000	12,600,000
Total high level, . .	26,385,000	30,088,000	45,209,000	-	-	-	31,063,000	35,500,000	53,250,000	-	-	-
Total low level, . .	-	-	-	50,274,000	57,329,000	86,142,000	-	-	-	59,063,000	67,500,000	101,250,000

Relief for the Existing Charles River Main Sewer.

Until an extension of the High-level Sewer to the territory proposed shall have been constructed, the volume of sewage from both high and low districts, set forth in Table No. 7, will continue to be tributary to the existing Charles River valley sewer. The capacity of this sewer and its relation to volumes of sewage flow from the whole district are set forth graphically on diagrams Nos. 1, 2 and 3: at Vancouver Street, in the Back Bay district of Boston; above Brookline, at the Brighton-Newton line; and at the end of the Charles River main sewer in Newton.

From the table and diagrams it appears that as early as 1907 overflows during storms will undoubtedly occur through Brighton and Brookline, and that dry weather flows may fill the sewer about 1915 through the same territory. The large pumps of the Ward Street station will doubtless quicken the flow of sewage in the lower section of this main sewer. It is not anticipated that they can materially delay the date when storm overflows will occur. Relief for this district should be provided at an early date, before the storm overflows become so frequent and offensive as to be objectionable in the lower Charles River basin. Above Brighton, through the city of Newton, relief may be delayed for ten years, until 1915 or later.

The future condition of the existing Charles River valley main sewer after it shall have been relieved by the proposed extension above Jamaica Plain is exhibited on diagrams Nos. 4, 5 and 6. From these diagrams it appears that storm overflows from this sewer may be expected from 1920 to 1925, and that dry weather flows may fill the sewer in the year 1930 or later.

DIAGRAM NO. 1. — *Comparison of the Estimated Flow of Sewage and the Capacity of the Charles River Valley Sewer at Vancouver and Ruggles Streets, Back Bay, using Total Estimated High-level and Low-level Populations.*

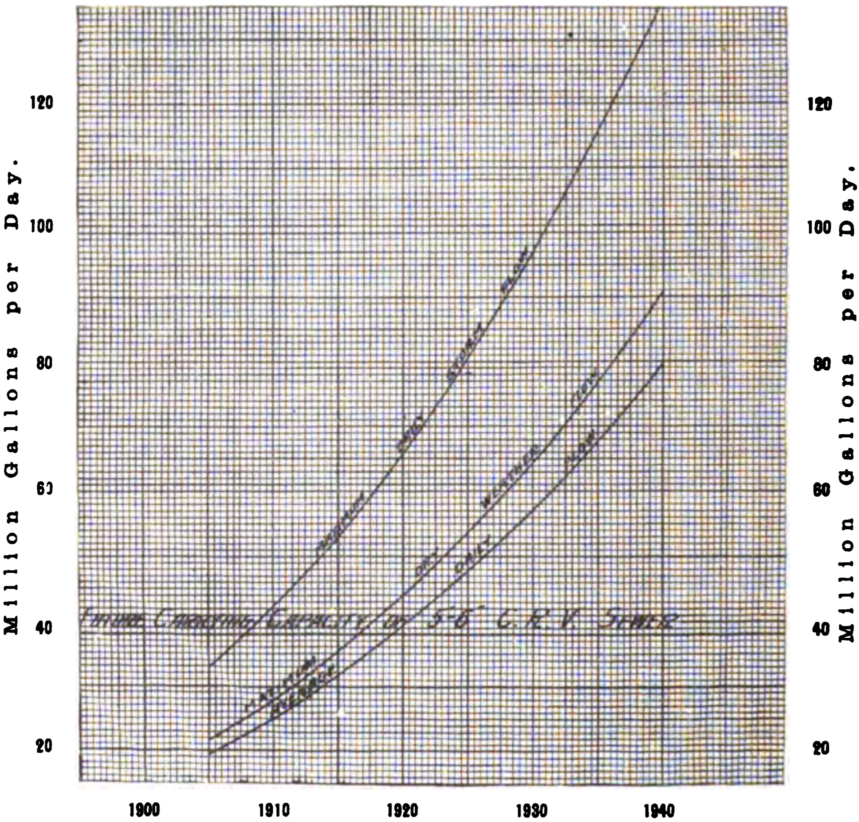


DIAGRAM No. 2. — *Comparison of the Estimated Flow of Sewage and the Capacity of the Charles River Valley Sewer at Cottage Farm, Brighton, using Total Estimated High-level and Low-level Populations.*

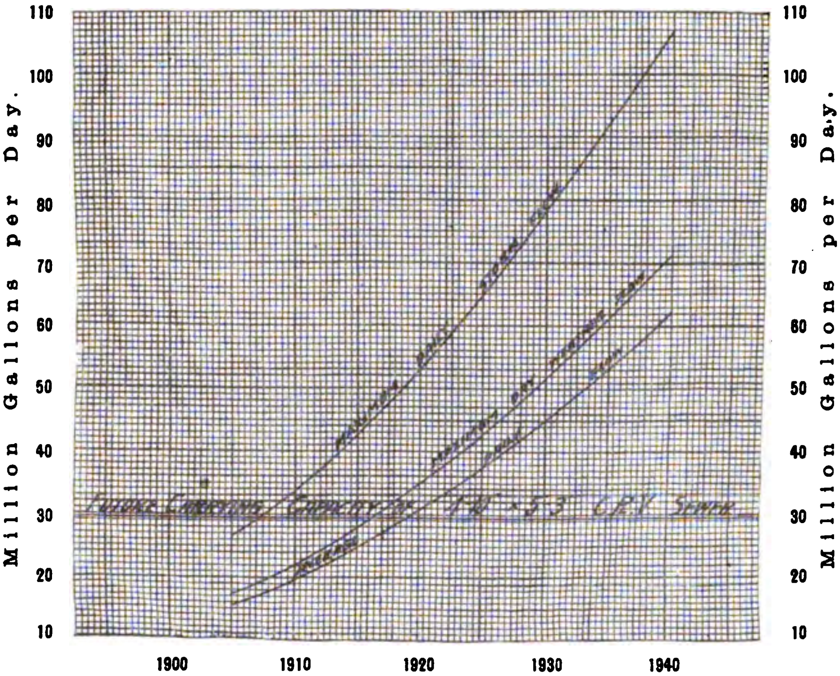


DIAGRAM No. 3. — *Comparison of the Estimated Flow of Sewage and the Capacity of the Charles River Valley Sewer at Cheesecake Brook, Newton, and at Newton-Brighton Town Line, using Total Estimated High-level and Low-level Populations.*

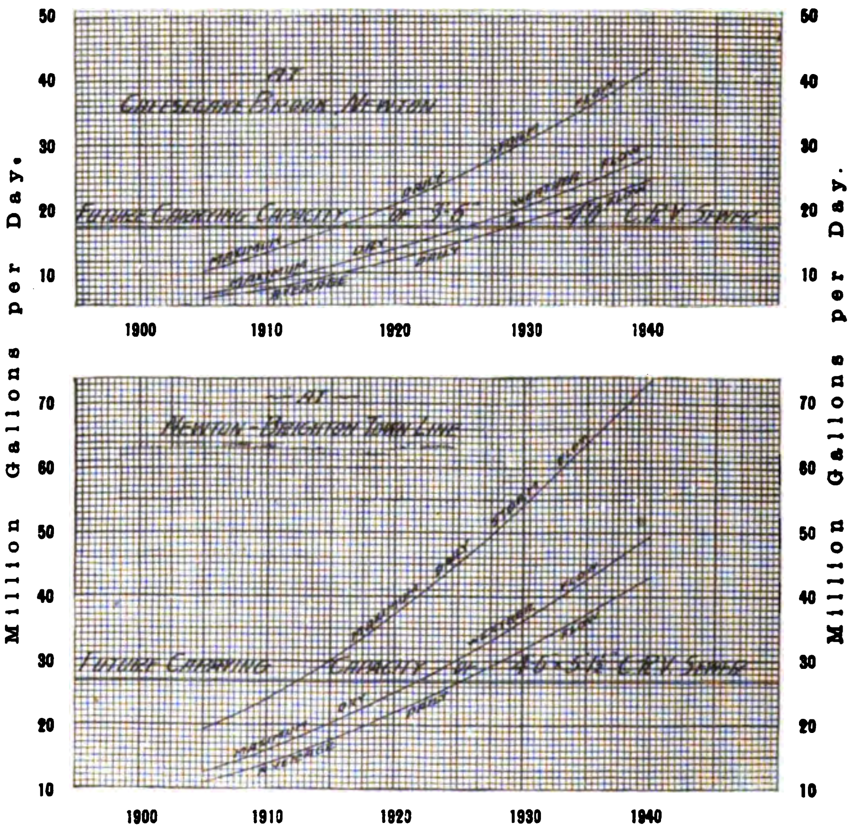


Diagram No. 4. — *Comparison of the Estimated Flow of Sewage and the Capacity of the Charles River Valley Sewer at Vancouver and Ruggles Streets, Back Bay, using Total Estimated Low-level Populations.*

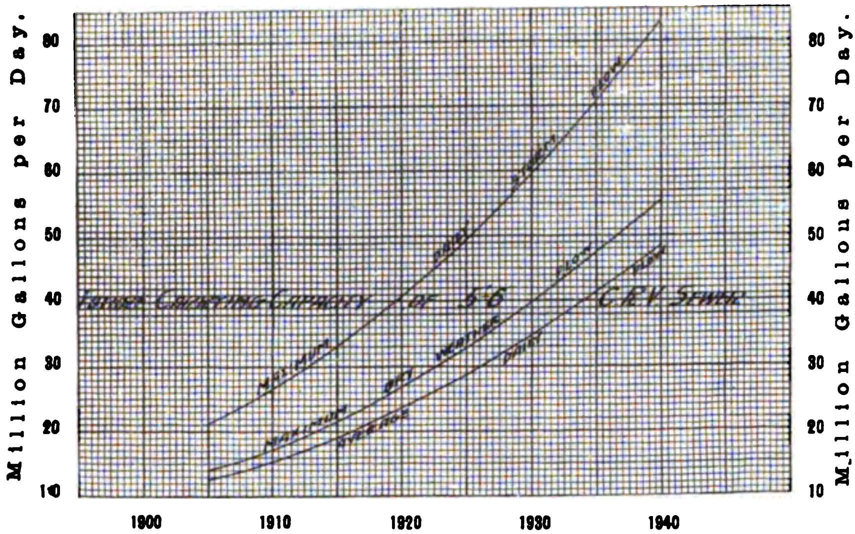


Diagram No. 5. — *Comparison of the Estimated Flow of Sewage and the Capacity of the Charles River Valley Sewer at Cottage Farm, Brighton, using Total Estimated Low-level Populations.*

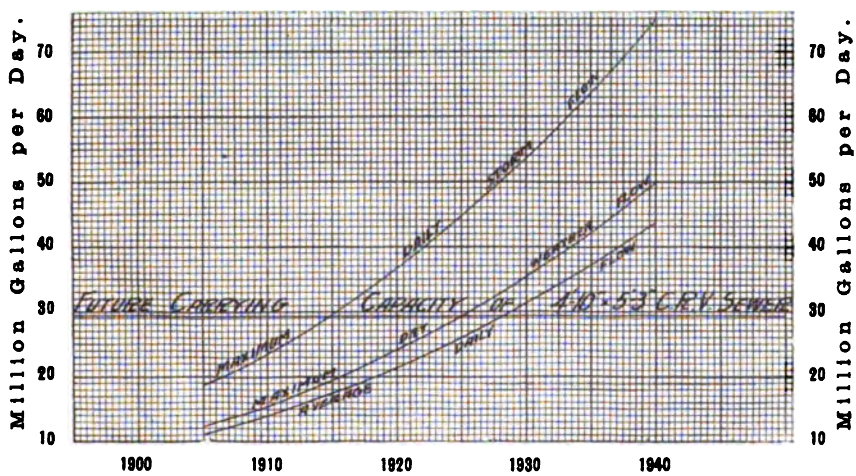
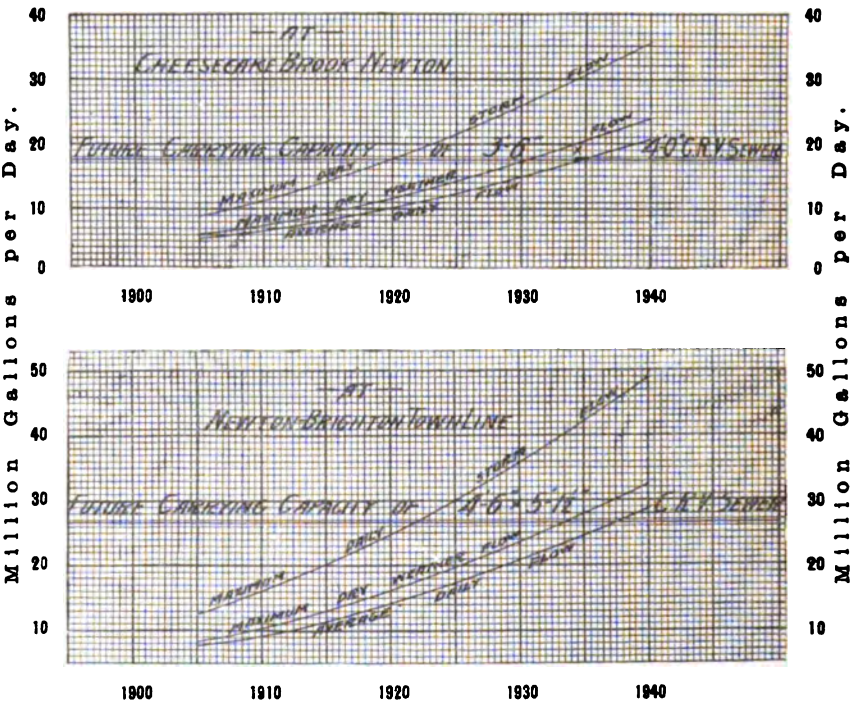


Diagram No. 6. — *Comparison of the Estimated Flow of Sewage and the Capacity of the Charles River Valley Sewer at Cheesecake Brook, Newton, and at Newton-Brighton Town Line, using Total Estimated Low-level Populations.*



Possible Future Additions to the South Metropolitan System.

Under authority of chapter 65 of the Resolves of 1899, the State Board of Health reviewed the project for a high-level gravity sewer for the relief of the Charles and Neponset River valley Metropolitan areas, and, among other suggestions in relation thereto, recommended that small areas in the towns of Weston, Wellesley and Needham, along the westerly border of the Charles River, be added to the South Metropolitan District. By legislative act, the district is limited at present by the easterly border of the Charles River at Newton and Waltham. The South Metropolitan District and the area recommended to be added are both outlined on the general map.

The present population on the area that may be added west of the Charles River is about 2,800, and in 1940 may be 15,000. This area is so located that its drainage may be collected without pumping in an existing main sewer of the city of Newton, which extends from near the end of the Charles River Metropolitan sewer through Auburndale and Newton Lower Falls. If at a future date this portion of Weston, Wellesley and Needham should be added to the South Metropolitan District by legislative act, its drainage may be provided for by purchasing a length of about 7 miles of local main sewer of the city of Newton, and incorporating it as a section of the Metropolitan System. This length of sewer is shown on the general map and outlined in Table No. 8 : —

TABLE No. 8. — *Newton Main Sewers that may be purchased to provide for Drainage of Wellesley and Needham.*

SIZE.	Length (Miles).	Location.	Remarks.
24"×36", ...	5.15	From Charles River valley sewer along Cheesecake Brook, Watertown, Washington and Border streets, private land, Commonwealth Avenue, Bourne and Charles streets, along Charles River, St. Mary's, Concord and Washington streets.	4.45 miles earth open cut, .68 mile rock open cut, .02 mile earth tunnel.
20"×30", ...	2.13	In Washington Street, Quinobequin Road and along Charles River to Eliot Street.	1.43 miles earth open cut, .59 mile rock open cut, .11 mile rock tunnel.
20" cast-iron pipe, . .	.05	Along Charles River near Echo Bridge,	Rock open cut.
6", 8" and 16" cast-iron pipe siphons.	.07	Across Charles River near Echo Bridge,	Rock cut.
Total, . . .	7.40		

This length of sewer was constructed by the city of Newton at a cost of $289,000. It would be necessary to extend pipes across the Charles River at several points where drainage of this added district will naturally collect, and these pipes and the purchase of the local sewer of the city of Newton would involve an expenditure of about $300,000 to provide for the future drainage from these added areas. The drainage from so small a population as outlined for these areas can safely be provided for in the existing Newton sewer for many years. The addition of these areas to the South Metropolitan District will hasten the necessity of future relief for the Charles River main sewer by a few years.

Extension of High-level Sewer recommended.

The extension recommended is outlined on the general plan and profile accompanying this report. The lengths, sizes and elevations of the sewer are set forth in Table No. 9 : —

TABLE No. 9. — *Showing Lengths, Sizes and Elevations of the Extension of High-level Sewer as recommended.*

City or Town.	Location.	Size.	Length.	Elevation.		Remarks.
				From	To	
West Roxbury, . .	Perkins Street, ...	6' 6"×7', . .	700	132.00	132.23	Rock tunnel.
	Perkins and Chestnut streets, ...	7' diameter, . .	2,385	132.23	133.05	Air tunnel.
Brookline, . . .	Chestnut and Kendall streets, ...	7' diameter, . .	1,915	133.05	133.67	Air tunnel.
	Kendall and Cypress streets, Brington Road, private land, Gorham Avenue, Greenough, Washington and Park streets.	6' 6"×7', . .	4,475	133.67	135.15	Rock tunnel and earth open cut.
	Park, Beacon and Winchester streets, private land and Columbia Street.	6' 3"×6' 6", . .	5,370	135.40	137.20	Earth open cut and earth tunnel.
Brighton, . . .	Columbia Street, Commonwealth Avenue, Warren, Cambridge and Washington streets.	5' 9"×6', . .	7,955	137.20	139.88	Open cut, rock tunnel and earth tunnel.
	Washington Street, ...	60" cast-iron pipe,	1,200	139.88	140.88	Open cut.
	Washington and Tremont streets, ...	5' 9"×6', . .	2,553	140.88	141.76	Open cut.
Newton, . . .	Tremont, Park and Vernon streets, ...	5'×5' 3", . .	2,700	142.05	143.13	Open cut.
	Vernon and Eldredge streets, private land, Hollis and Centre streets.	60" cast-iron pipe,	1,650	143.13	144.00	Open cut.
	Mt. Ida Street, private land, Lewis Street, private land and Cabot Park.	5'×5' 3", . .	3,200	144.00	145.28	Rock tunnel and earth open cut.
	Private land, Norwood Avenue, Harvard Street and Washington Park.	60" cast-iron pipe,	1,400	145.28	146.02	Open cut.
	Washington Park, ...	5'×5' 3", . .	1,390	146.02	146.58	Open cut.
	Walnut Street, Highland and Elmwood avenues, Austin Street, Clark Place, private land, Margin, Lincoln and Washington streets.	4' 3"×4' 6", . .	8,182	146.83	150.92	Earth and rock open cut and rock tunnel.
	Washington Street, ...	4', ...	8,682	151.40	156.83	Earth open cut, rock and earth tunnel.

Total length = 53,757 feet = 10.18 miles.

From this table it appears that the extension recommended involves a length of 10 miles of trunk sewer, varying in size from 7 to 4 feet in diameter. The anticipated volumes of sewage, outlined in Table No. 7, at the rate of inclination recommended, will fill the sewers to about two-thirds of their height. The minimum inclination or rate of grade adopted will produce scouring velocities when the sewer is running one-fourth full. This will probably be its condition when constructed and put into operation.

The location recommended is at considerable distance inland from the Charles River, and, as shown on the profile, the construction necessarily involves a series of deep excavations where the sewer pierces the divides between brooks, followed by a series of shallow excavations crossing the valleys. Near Oak Square in Brighton, and in Vernon, Eldredge, Hollis, Norwood and Harvard streets in Newton, the arch of the sewer will approach so near to the street surface that the introduction of short lengths of 60-inch cast-iron pipe is recommended. Passing these locations, it will be necessary to construct short lengths of small local lateral sewers, to intercept house drains that may be broken off by the Metropolitan sewer.

In the sewer route recommended no attempt has been made to follow the outline of the high-level district, the location following generally in public highways and along the shortest and most direct line. Two short branch lines would, however, be required in Brighton, reaching out to the borders of the district to intercept local main sewers, as indicated on the general map.

Beginning near the corner of Centre and Perkins streets in Jamaica Plain, the construction will follow westerly through Perkins Street in rock tunnel at a depth of about 70 feet below the surface for a distance of 700 feet, where the construction will leave the rock and enter strata of wet sand and gravel, passing the northerly end of Jamaica Pond. To secure impermeability to masonry and maintain the present level of the water of the pond, the sewer will need to be constructed by pneumatic process along Perkins Street, Jamaica Plain, and Chestnut Street, Brookline, for a distance of about 4,300 feet, to the corner of Chestnut and Kendall streets in Brookline, where rock will again be encountered. Beyond Chestnut Street the route recommended follows along Kendall and Cypress streets to Boylston Street in rock tunnel, for a distance of 1,500 feet. Beyond Boylston Street the route follows in earth

cut, generally in sand and gravel, at an average depth of 20 feet, through Cypress Street, Brington Road and private land under the Boston & Albany Railroad near the Brookline Hills station, through the Brookline playground, to the corner of Gorham Avenue and Davis Street; and thence through Gorham Avenue, Greenough, Washington and Park streets, a total distance of 2,975 feet. In Park Street, near Washington Street, the size of the sewer will be reduced from 6 feet 6 inches by 7 feet to 6 feet 3 inches by 6 feet 6 inches. The sewer will continue through Park, Beacon and Winchester streets in open cut at an average depth of 25 feet to a point in Winchester Street near Beacon Street, a distance of 2,150 feet; here it will enter earth tunnel about 35 feet below the surface, extending through Winchester Street and private land to Columbia Street, a distance in tunnel of 2,125 feet. Following through Columbia Street in open cut in sand and gravel for a distance of 1,095 feet, the size will again be reduced to 5 feet 9 inches by 6 feet near the Brookline-Brighton boundary line.

In Brighton the route recommended follows westerly in Columbia Street and Commonwealth Avenue, in open cut in sand and gravel at a depth of 20 feet, for a distance of 1,255 feet to near Allston Street. Beyond Allston Street the construction will enter rock tunnel about 60 feet below the surface, extending along Commonwealth Avenue and Warren, Cambridge and Washington streets for a distance of 5,100 feet to near Parsons Street; thence continuing in Washington Street to near Lake Street in earth tunnel at a depth of 30 feet below the surface, for a distance of 1,100 feet.

A 20-inch by 26-inch branch line in rock tunnel through Cambridge Street from Saunders Street, and a 24-inch by 28-inch branch line in sand and gravel open cut and in tunnel partly in earth and partly in rock through Market Street from Mapleton Street will enter the main sewer at Warren and Washington streets, respectively, reaching out to the northerly border of the high-level district.

Beyond Lake Street the sewer will be constructed in open cut at a depth of 18 feet, generally in sand and gravel, for a distance of 500 feet; thence continuing in Washington Street in shallower open cut for a distance of 1,200 feet, necessitating the introduction of 60-inch cast-iron pipe in place of the usual masonry sewer. From this section of iron pipe the line recommended continues in open cut at an average depth of 22 feet for a distance of 1,893 feet

through Washington Street to Oak Square and through Tremont Street; thence partly in rock and partly in earth open cut for a distance of 660 feet to the Brighton-Newton boundary line, where the size will be reduced to 5 feet by 5 feet 3 inches.

In Newton the route will follow along Tremont Street in rock tunnel for a distance of 2,060 feet; and thence in earth and rock cut for a distance of 640 feet through Tremont, Park and Vernon streets. Beyond this point, for a distance of 1,650 feet, 60-inch cast-iron pipe will be introduced in Vernon and Eldredge streets, private land, Hollis and Centre streets to near Mt. Ida Street. Beyond the iron pipe, for a distance of 348 feet in Mt. Ida Street to Newtonville Avenue, the usual masonry sewer will be constructed in sand and gravel. From Newtonville Avenue westerly the sewer will be located in rock tunnel under Mt. Ida at a maximum depth of 150 feet, largely under private land and in Lewis Street to near East Side Parkway, a distance of 2,450 feet. Through Cabot Park the route will follow in open cut at an average depth of 12 feet for a distance of 402 feet to Laundry Brook. Beyond the brook a section of 60-inch cast-iron pipe will extend for a distance of 1,400 feet through private land, Norwood Avenue, Harvard Street and Washington Park; followed by a 5-foot by 5-foot 3-inch masonry sewer at a depth of about 15 feet through Washington Park to Walnut Street, a distance of 1,390 feet. Beyond Washington Park the sewer will be reduced to 4 feet 3 inches by 4 feet 6 inches, and will continue through Walnut Street and Highland Avenue, Elmwood Avenue and Austin Street in sand and gravel at an average depth of 14 feet, for a distance of 1,908 feet. From this point the sewer will enter rock tunnel at a depth of 25 feet below the surface for a distance of 1,324 feet through Austin and Mt. Vernon streets, Clark Place and private land; thence in rock and earth cut at an average depth of 14 feet through private lands along the Boston & Albany Railroad and Margin Street to near Putnam Street, a distance of 3,125 feet. From Putnam Street the route recommended follows through Margin, Lincoln and Washington streets in sand and gravel cut about 13 feet deep for a distance of 1,825 feet to Cheesecake Brook at Auburn Street. The sewer will cross Cheesecake Brook by a 36-inch cast-iron pipe siphon. Beyond the brook the sewer will be reduced in size to 4 feet in diameter, and will continue in Washington Street in sand and gravel cut at an average depth of 16

feet to near Greenough Street, a distance of 1,325 feet. At this point the sewer will enter rock tunnel under Washington Street at an average depth of about 50 feet below the surface and extend for a distance of 6,000 feet; thence through an earth tunnel for a distance of 1,357 feet to the Newton main sewer in Newton Lower Falls near the corner of Washington Street and Quinobequin Road, the end of the proposed High-level Sewer extension.

Estimate of Cost.

The following is an estimate of the cost of constructing an extension of the High-level Sewer from the corner of Centre and Perkins streets, Jamaica Plain, over the route shown on the general map and outlined in the foregoing description: —

TABLE No. 10. — *Estimated Cost of Extension of High-level Sewer above Jamaica Plain through West Roxbury, Brookline, Brighton and Newton.*

LOCATION.	Size.	Average Depth.	Length.	Cost per Foot.	Cost.	Total Cost.	Remarks.
West Roxbury: —							
In Perkins Street from Centre Street to a point about 200 feet west of South Huntington Avenue,	6' 6"×7',	-	700	$40 70	$28,490 00	-	Rock tunnel.
In Perkins and Chestnut streets to the boundary line between West Roxbury and Brookline,	7' diameter,	-	2,385	77 00	183,645 00	-	Air tunnel.
Total,	- -	-	-	-	$212,135 00	-	
Engineering and contingencies, 15 per cent.,	- -	-	-	-	31,820 00	-	
Total cost in West Roxbury,	- -	-	-	-		$243,955 00	
Brookline: —							
In Chestnut and Kendall streets from the boundary line between West Roxbury and Brookline to a point near Kendall Place,	7' diameter,	-	1,915	77 00	$147,455 00	-	Air tunnel.
In Kendall and Cypress streets to near Boylston Street,	6' 6"×7',	-	1,500	40 70	61,050 00	-	Rock tunnel.
In Cypress Street, Brington Road, private land, Gorham Avenue, Greenough, Washington and Park streets to a point about 30 feet north of Washington Street,	6' 6"×7',	19.0	2,975	23 00	68,425 00	-	Earth open cut.
In Park, Beacon and Winchester streets to a point 100 feet north of Beacon Street,	6' 3"×6' 6",	25.0	2,150	24 00	51,600 00	-	Earth open cut.
In Winchester Street and private land,	6' 3"×6' 6",	-	2,125	46 00	97,750 00	-	Air tunnel.
Amounts carried forward,	- -	-	-	-	$426,280 00	$243,955 00	

TABLE NO. 10. — *Estimated Cost of Extension of High-level Sewer above Jamaica Plain through West Roxbury, Brookline, Brighton and Newton* — Continued.

LOCATION.	Size.	Average Depth.	Length.	Cost per Foot.	Cost.	Total Cost.	Remarks.
Amounts brought forward,	- -	-	-	-	$426,280 00	$243,955 00	
Brookline — *Concluded.*							
In private land and Columbia Street to the Brighton boundary line,	6' 3"×6' 6",	15.0	1,095	$17 40	19,053 00	-	Earth open cut.
Total,	- -	-	-	-	$445,333 00	-	
Engineering and contingencies, 15 per cent.,	- -	-	-	-	66,800 00	-	
Total cost of construction,	- -	-	-	-	$512,133 00	-	
Rights of way,	- -	-	-	-	17,000 00	-	
Total cost in Brookline,	- -	-	-	-		529 133 00	
Brighton: —							
In Columbia Street and Commonwealth Avenue to a point 50 feet west of Allston Street,	5' 9"×6',	19.0	1,255	20 00	$25,100 00	-	Earth open cut.
In Commonwealth Avenue, Warren, Cambridge and Washington streets to Parsons Street,	5' 9"×6',	-	5,100	34 50	175,950 00	-	Rock tunnel.
In Washington Street to a point 200 feet east of Lake Street,	5' 9"×6',	-	1,100	42 50	46,750 00	-	Earth tunnel.
In Washington Street to a point 300 feet west of Lake Street,	5' 9"×6',	18.0	500	19 50	9,750 00	-	Earth open cut.
In Washington Street to near Montfern Avenue,	60" cast-iron pipe,	10.0	1,200	23 50	28,200 00	-	Earth open cut.
In Washington Street to Oak Square,	5' 9"×6',	16.0	750	18 00	13,500 00	-	Earth open cut.
Branch lines in Cambridge, Market, Bennett and Washington streets,	20"×26",	-	2,250	16 00	36,000 00	-	Tunnel.
	24"×28", 15", 12",	12.0	2,800	3 20	8,960 00	-	Earth open cut.
Total,	- -	-	-	-	$344,210 00	-	
Engineering and contingencies, 15 per cent.,	- -	-	-	-	51,630 00	-	
Total cost in Brighton to Oak Square,	- -	-	-	-		395,840 00	
Amount carried forward,	- -	-	-	-	-	$1,168,928 00	

Table No. 10. — *Estimated Cost of Extension of High-level Sewer above Jamaica Plain through West Roxbury, Brookline, Brighton and Newton* — Continued.

Location.	Size.	Average Depth.	Length.	Cost per Foot.	Cost.	Total Cost.	Remarks.
Amount brought forward,	- -	-	-	-	-	$1,168,928 00	
Brighton — *Concluded.*							
In Washington and Tremont streets to about 700 feet east of Brighton boundary line,	5' 9"×6',	24.5	1,143	$23 00	$26,289 00	-	Earth open cut.
In Tremont Street to the Newton-Brighton boundary line,	5' 9"×6',	27.5	660	33 00	21,780 00	-	Earth and rock open cut.
Total,	- -	-	-	-	$48,069 00	-	
Engineering and contingencies, 15 per cent.,	- -	-	-	-	7,210 00	-	
Total cost of construction Oak Square to Newton line,	- -	-	-	-		55,279 00	
Newton: —							
In Tremont Street to a point about 300 feet east of Park Street,	5'×5' 3",	-	2,060	23 50	$48,410 00	-	Rock tunnel.
In Tremont, Park and Vernon streets to a point 100 feet west of Park Street,	5'×5' 3",	14.0	640	15 50	9,920 00	-	Rock and earth open cut.
In Vernon and Eldredge streets, private land, Hollis and Centre streets to Mt. Ida Street,	60" cast-iron pipe,	9.5	1,650	23 00	37,950 00	-	Earth open cut.
In Mt. Ida Street to Newtonville Avenue,	5'×5' 3",	17.5	348	15 50	5,394 00	-	Earth open cut.
In private lands and Lewis Street,	5'×5' 3",	-	2,450	23 50	57,575 00	-	Rock tunnel.
In private land and Cabot Park to Laundry Brook,	5'×5' 3",	11.0	402	13 50	5,427 00	-	Earth open cut.
In private land, Norwood Avenue, Harvard Street and Washington Park to a point 100 feet west of Harvard Street,	60" cast-iron pipe,	7.0	1,400	22 00	30,800 00	-	Earth open cut.
In Washington Park to Walnut Street,	5'×5' 3",	15.0	1,390	13 00	18,070 00	-	Earth open cut.
In Walnut Street, Highland and Elmwood avenues and Austin Street to a point about 300 feet west of Elmwood Avenue,	4' 3"×4' 6",	14.0	1,908	11 50	21,942 00	-	Earth open cut.
In Austin and Mt. Vernon streets, Clark Place and private land to a point about 500 feet west of Clark Place,	4' 3"×4' 6",	-	1,324	21 00	27,804 00	-	Rock tunnel.
Amounts carried forward,	- -	-	-	-	$263,292 00	$1,224,207 00	

TABLE No. 10. — *Estimated Cost of Extension of High-level Sewer above Jamaica Plain through West Roxbury, Brookline, Brighton and Newton* — Concluded.

LOCATION.	Size.	Average Depth.	Length.	Cost per Foot.	Cost.	Total Cost.	Remarks.
Amounts brought forward,	- -	-	-	-	$263,292 00	$1,224,207 00	
Newton — *Concluded.*							
In private land along Boston & Albany Railroad and in Margin Street to a point about 200 feet east of Putnam Street,	4' 3"×4' 6",	14.0	3,125	$14 80	46,250 00	-	Earth and rock open cut.
In Margin, Lincoln and Washington streets to Cheesecake Brook,	4' 3"×4' 6",	13.5	1,825	12 20	22,265 00	-	Earth open cut.
In Washington Street to a point about 300 feet west of Greenough Street,	4' diameter,	16.0	1,325	11 40	15,105 00	-	Earth open cut.
In Washington Street to a point 300 feet west of Beacon Street,	4' diameter,	-	6,000	21 50	129,000 00	-	Rock tunnel.
In Washington Street to the Newton main sewer, near Quinobequin Road,	4' diameter,	-	1,357	21 00	28,497 00	-	Earth tunnel.
Branch sewers and changes in sewers and drains,	- -	-	-	-	30,980 00	-	
Total,	- -	-	-	-	$535,389 00	-	
Engineering and contingencies, 15 per cent.,	- -	-	-	-	80,310 00	-	
Total cost of construction,	- -	-	-	-	$615,699 00	-	
Rights of way,	- -	-	-	-	50,000 00	-	
Total cost in Newton,	- -	-	-	-		665,699 00	
Total estimated cost of High-level Sewer above Jamaica Plain over the route shown upon the general map, and outlined in the accompanying report,	- -	-	-	-	-	$1,889,906 00	

This estimate of cost is based upon the provision that in the air tunnels the masonry sections shall be of rings of Portland brickwork 8 inches and 12 inches in thickness; that the arches of the rock tunnels shall be lined with Portland concrete, and the inverts shall be paved with a 4-inch lining of Portland brickwork, reinforced with Portland concrete; that in the rock and earth sections in the open cut trenches the arches shall be of brick, laid in Rosendale cement in dry ground and in Portland cement where water is encountered; and the inverts shall be lined with 4 inches of Portland brickwork, reinforced with Portland concrete; and that the cast-iron pipe sections shall be entirely surrounded by Portland concrete.

From the foregoing table it appears that the construction of the proposed extension from the junction with the High-level Sewer near the corner of Centre and Perkins streets, Jamaica Plain, to Oak Square in Brighton, the part which is needed at the earlier date, is estimated to cost $1,168,928; that the construction of the remainder of the sewer, from Oak Square to the end at Newton Lower Falls, is estimated to cost $720,978; and that the cost of the entire extension over the route recommended is estimated at $1,889,906.

Respectfully submitted,

WM. M. BROWN,
Engineer Sewerage Works.

BOSTON, January 1, 1905.

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APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

[NOTE. — The details of contracts made before

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	210†	Excavating soil, . . .	3	$377,830 00	$360,870 00*	Newell & Snowling Construction Company.
2	257	Excavating soil, . . .	6	449,300 00	414,987 50*	Bruno, Salomone & Petitti.
3	264†	Arch bridges and abutments.	8	42,470 00	37,335 00*	The George M. Atkins Company.
4	268†	Placing riprap on the westerly portion of the North Dike.	-‡	-‡	-‡	The McArthur Brothers Company.
5	277†	Masonry arch bridge, West Boylston, Mass.	8	14,820 00	12,388 00*	F. A. McCauliff, Fitchburg, Mass.
		Total, ...	. .	. . .	. . .	. . . . . .

Contracts relating to the

6	195	Wachusett Dam, . .	11	$1,680,870 00	$1,603,635 00*	McArthur Brothers Company.
7	245	Section 2 of relocation of Central Massachusetts Railroad (extension of Contract No. 195).	-‡	-‡	-‡	McArthur Brothers Company.
8	263†	Sluice valves for Wachusett Dam.	-‡	-‡	7,887 00	Coffin Valve Company,
9	275†	South Dike of Wachusett Reservoir.	4	124,285 00	118,570 00*	John F. Magee & Co., .
10	276†	Superstructure of lower gate-chamber of Wachusett Dam.	7	76,563 00	72,595 00*	Connery & Wentworth, Boston, Mass.
11	278†	Bronze grooves for Wachusett Dam.	-‡	-‡	3,691 00	The Wm. Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.
12	279†	Valves for Wachusett Dam; 4 36-inch, 1 20-inch, 1 12-inch, 1 10-inch.	2	2,345 00	2,317 67*	Chapman Valve Manufacturing Company, Indian Orchard, Mass.

* Contract based upon this bid. † Contract completed.

‡ Competitive bids were not received on this contract.

Appendix No. 1.

THE YEAR 1904 — WATER WORKS.

Reservoir Department.

1904 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1904.	10. Value of Work done Dec. 31, 1904.	
Aug. 1, '01,	Nov. 26, '04,	- -	$395,092 50	1
Dec. 27, '02,	-	- -	450,000 00	2
April 16, '03,	Dec. 23, '03,	- -	38,528 22	3
May 16, '03,	Nov. 18, '04,	- -	51,017 50	4
June 23, '04,	Sept. 28, '04,	For Portland cement concrete masonry, $5.75 per cu. yd.; ashlar masonry, $16 per cu. yd.	12,809 65	5
. . .	. . .	. . . .	$947,447 87	

Dam and Aqueduct Department.

Oct. 1, '00,	-	- -	$1,454,840 00	6
April 18, '02,	-	- -	256,489 34	7
April 30, '03,	April 7, '04,	- -	7,887 00	8
Dec. 26, '03,	Dec. 8, '04,	- -	139,411 04	9
Mar. 18, '04,	Dec. 22, '04,	For whole work, $72,595, ...	72,937 34	10
May 25, '04,	Aug. 8, '04,	For whole work, $3,691, ...	3,691 00	11
July 15, '04,	Dec. 16, '04,	For whole work, $2,317.67, ...	2,317 67	12

CONTRACTS MADE AND PENDING DURING THE

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	280†	34,740 lbs. castings for Wachusett Dam.	6	$1,846 17	$1,215 90*	Davis & Farnum Manufacturing Company, Waltham, Mass.
2	281†	76,945 lbs. castings for Wachusett Dam.	6	2,596 89	2,431 46*	Gibby Foundry Company, Boston, Mass.
		Total, ...	. .	. . .	. . .	. . . .

Contracts relating to the

3	199†	Section 2, Weston Aqueduct.	8	$234,581 50	$200,477 00*	Shanahan, Casparis & Co.
4	200†	Section 3, Weston Aqueduct.	9	131,226 10	127,507 50*	Shanahan, Casparis & Co.
5	203†	Section 6, Weston Aqueduct.	14	121,497 00	120,646 50*	Shanahan, Casparis & Co.
6	204†	Section 12, Weston Aqueduct.	16	139,197 50	134,096 50*	Shanahan, Casparis & Co.
7	205†	Section 13, Weston Aqueduct.	9	364,884 00	346,290 00*	Michael H. Keefe, assigned on Oct. 12, 1901, to Columbus Construction Company.
8	211†	Sections 8 and 10, Weston Aqueduct.	11	155,508 50	146,130 00*	Winston & Co., . .
9	212†	Section 11, Weston Aqueduct.	10	157,270 00	148,635 00*	Winston & Co., . .
10	213†	Section 15, Weston Aqueduct.	5	197,556 00	171,645 00*	Winston & Co., . .
11	218†	Section 14, Weston Aqueduct.	10	68,364 00	58,490 00*	Nawn & Brock, . .
12	219†	Section 1 of the Weston Reservoir.	11	64,971 25	59,587 50*	Nawn & Brock, . .
13	220†	Section 2 of the Weston Reservoir.	9	90,152 50	88,292 50*	Nawn & Brock, . .
14	267†	Superstructures of channel, and screen chambers of the Weston Aqueduct.	7	12,475 00*	9,150 00	Woodbury & Leighton Company.
15	271†	Superstructures of head and meter chambers of the Weston Aqueduct.	5	12,325 00	10,804 00*	C. A. Dodge & Company.
		Total, ...	. .	. . .	. . .	. . . .

Contracts relating to the

16	235†	Laying water pipes in Newton.	6	$53,121 75	$50,976 00*	D. F. O'Connell, . .
		Total, ...	. .	. . .	. . .	. . . .

* Contract based upon this bid. † Contract completed.

YEAR 1904 — WATER WORKS — *Continued.*

Dam and Aqueduct Department — Concluded.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1904.	10. Value of Work done Dec. 31, 1904.	
Aug. 12, '04,	Dec. 20, '04,	For all castings, $0.035 per lb.,	$1,248 97	1
Aug. 12, '04,	Dec. 31, '04,	For all castings, $0.0316 per lb.,	2,586 63	2
. . .	. . .	. . .	$1,940,808 99	

Weston Aqueduct Department.

May 9, '01,	Oct. 9, '03,	- -	$205,159 54	3
May 9, '01,	Oct. 9, '03,	- -	131,062 48	4
May 9, '01,	Sept. 26, '03,	- -	116,641 31	5
May 9, '01,	Oct. 7, '03,	- -	142,021 55	6
May 20, '01,	Nov. 11, '03,	- -	417,252 64	7
Aug. 28, '01,	Nov. 21, '03,	- -	150,101 77	8
Aug. 28, '01,	Nov. 14, '03,	- -	159,892 59	9
Aug. 28, '01,	Nov. 28, '03,	- -	188,374 58	10
Nov. 26, '01,	May 20, '04,	- -	59,449 04	11
Nov. 26, '01,	May 20, '04,	- -	63,778 33	12
Nov. 26, '01,	May 20, '04,	- -	128,970 70	13
June 4, '03,	April 8, '04,	- -	12,484 75	14
July 6, '03,	Nov. 28, '03,	- -	10,804 00	15
. . .	. . .	. . .	$1,775,993 28	

Distribution Department.

April 7, '02,	April 21, '03,	- -	$71,287 87	16
. . .	. . .	. . .	$71,287 87	

CONTRACTS MADE AND PENDING DURING THE YEAR 1904 — WATER WORKS — *Concluded.*

Summary of Contracts.*

	Value of Work done December 31, 1904.
Wachusett Reservoir, 6 contracts,	$1,086,858 91
Relocation of Central Massachusetts Railroad, 1 contract,	256,439 34
Wachusett Dam, 7 contracts,	1,544,958 61
Weston Aqueduct and Reservoir, 13 contracts,	1,775,993 28
Distribution Department, 1 contract,	71,287 87
Total of 28 contracts made and pending during the year 1904,	$4,735,538 01
248 contracts completed from 1896 to 1903, inclusive,	10,525,722 64
	$15,261,260 65
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston,	512,000 00
Total of 287 contracts,	$14,749,260 65

* In this summary, contracts charged to maintenance are excluded.

Appendix No. 2.

Cement Tests — Water Works.

The following tables contain: —

1. Long-time tests of natural cements used by the Dam and Aqueduct, and Reservoir departments during the years 1896 to 1900, inclusive.

2. Long-time tests of Portland cements used by the Dam and Aqueduct, and Reservoir departments during the years 1896 to 1900, inclusive.

3. Tests of cements used in the construction of the Wachusett Dam and other works at the Wachusett Reservoir during the years 1901 to 1904, inclusive.

4. Tests of cements used in the construction of the Weston Aqueduct during the years 1901 to 1903, inclusive.

The methods of testing were the same as described in Appendix No. 3 of the annual report of the year 1897.

Summary of Tests of All Brands of Natural Cement, of which Nine Aqueduct and Reservoir Departments

	BRAND.	Number of Barrels used.	Composition of Briquette.	Tensile Strength. Two Years. Number of Briquettes.	Tensile Strength. Two Years. Pounds per Square Inch.
1	Beach,	8,880	Neat,	64	467
			1 to 1,	64	316
2	Hoffman,	45,345	Neat,	106	467
			1 to 1,	106	327
3	Norton,	60,877	Neat,	60	440
			1 to 1,	60	295
4	Union,	900	Neat,	22	409
			1 to 1,	22	570
	Total,	115,502	Neat,	252	456
			1 to 1,	252	338

Summary of Tests of All Brands of Portland Cement, of which Nine Aqueduct and Reservoir Departments

	BRAND.	Number of Barrels used.	Composition of Briquette.	Tensile Strength. Eighteen Months. Number of Briquettes.	Tensile Strength. Eighteen Months. Pounds per Square Inch.
1	Atlas,	18,509	Neat,	65	848
			2 to 1,	65	324
2	Brooks-Shoobridge,	5,706	Neat,	5	674
			2 to 1,	5	521
3	Giant,	15,394	Neat,	55	598
			2 to 1,	55	426
4	Iron Clad,	7,778	Neat,	34	769
			2 to 1,	34	396
5	Stettin-Girstow,	979	Neat,	8	665
			2 to 1,	8	370
6	West Kent,	3,394	Neat,	19	586
			2 to 1,	19	522
	Total,	51,760	Neat,	186	721
			2 to 1,	186	395

Hundred Barrels or More were used on Construction Work by the Dam and from 1896 to 1900, inclusive.

Tensile Strength — Concluded.						
Three Years.		Five Years.		Seven and One-Half Years.		
Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	
50	482	23	506	10	462	1
50	349	24	369	10	420	
91	495	51	514	10	468	2
91	347	51	364	10	357	
54	456	28	479	3	452	3
54	314	27	325	3	371	
10	474	4	476	3	485	4
10	617	4	576	3	551	
205	480	106	501	26	465	
205	352	106	363	26	405	

Hundred Barrels or More were used on Construction Work by the Dam and from 1896 to 1900, Inclusive.

Tensile Strength — Concluded.								
Two Years.		Three Years.		Five Years.		Seven and One-Half Years.		
Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	
80	813	64	814	38	794	7	1,034	1
80	325	64	336	38	307	7	495	
55	702	53	696	30	698	13	672	2
55	447	53	449	30	443	13	448	
55	622	45	618	24	633	2	727	3
55	422	45	414	24	401	2	497	
34	800	26	826	18	838	2	698	4
34	394	26	378	18	369	2	378	
51	714	42	709	22	695	10	684	5
53	340	42	332	21	300	10	363	
59	589	51	570	29	562	17	548	6
59	434	51	424	29	391	17	409	
334	707	281	701	161	702	51	686	
336	389	281	389	157	365	51	424	

Summary of Tests of Cement used in the Construction of the Wachusett Dam

	BRAND.	NUMBER OF BARRELS USED. At Dam.	NUMBER OF BARRELS USED. Totals.	Composition of Briquette.	FINENESS. Per Cent. Residue on No 50 Sieve, 2,500 Meshes to Square Inch.	FINENESS. Per Cent. Residue on No. 100 Sieve, 10,000 Meshes to Square Inch.	FINENESS. Per Cent. Residue on No. 180 Sieve, 32,400 Meshes to Square Inch.	WIRE TESTS. Minutes to Bear Light Wire.	WIRE TESTS. Minutes to Bear Heavy Wire.	TENSILE STRENGTH. ONE DAY. Number of Briquettes.	TENSILE STRENGTH. ONE DAY. Pounds per Square Inch.
	Portland cement: —										
1	Alpha, . . .	150	491	Neat, .	.4	10.9	28.6	158	347	47	694
				2 to 1, .	-	-	-	-	316	-	-
2	Alsen, . . .	225	355	Neat, .	.4	11.2	26.4	116	291	31	625
				2 to 1, .	-	-	-	-	306	-	-
3	Atlas, . . .	3,064	3,763	Neat, .	.2	9.0	22.4	113	354	207	571
				2 to 1, .	-	-	-	-	287	-	-
4	Catskill, . .	-	305	Neat, .	.4	7.0	22.3	130	300	10	476
				2 to 1, .	-	-	-	-	298	-	-
5	Giant, . . .	62,659	65,641	Neat, .	.5	9.5	23.0	188	379	3,810	590
				2 to 1, .	-	-	-	-	378	-	-
6	Helderberg, . .	200	212	Neat, .	.2	5.0	19.9	173	480	23	383
				2 to 1, .	-	-	-	-	450	-	-
7	Iron Clad, . .	4,260	4,540	Neat, .	.1	4.2	17.1	86	304	222	652
				2 to 1, .	-	-	-	-	293	-	-
8	Lehigh, . .	4,140	10,783	Neat, .	.1	8.2	23.0	217	484	960	531
				2 to 1, .	-	-	-	-	481	-	-
9	Star, . . .	-	1,200	Neat, .	.5	9.8	24.4	154	336	51	691
				2 to 1, .	-	-	-	-	356	-	-
10	Stettin-Girstow, .	-	2,200	Neat, .	.7	8.3	21.3	62	178	252	377
				2 to 1, .	-	-	-	-	351	-	-
11	Whitehall, . .	150	150	Neat, .	.8	8.3	27.5	180	360	20	736
				2 to 1, .	-	-	-	-	450	-	-
	Total, . . .	74,848	89,590	Neat, .	1.8	10.7	22.5	142	380	5,633	574
				2 to 1, .	-	-	-	-	381	-	-
	Natural cement: —										
12	Union, . . .	175,060	175,060	Neat, .	1.0	6.3	13.7	66	133	6,689	174
				1 to 1, .	-	-	-	57	112	-	-
				2 to 1, .	-	-	-	-	-	-	-

Summary of Tests of Cements used in the Construction

	BRAND.	At Dam.	Totals.	Composition of Briquette.	Per Cent. Residue on No 50 Sieve	Per Cent. Residue on No. 100 Sieve	Per Cent. Residue on No. 180 Sieve	Minutes to Bear Light Wire.	Minutes to Bear Heavy Wire.	Number of Briquettes.	Pounds per Square Inch.
	Portland cement: —										
13	Atlas, . . .	-	91,875	Neat, .	.2	9.4	20.0	58	331	4,356	423
				2 to 1, .	-	-	-	-	417	-	-
14	Giant, . . .	-	7,653	Neat, .	.3	9.5	20.7	69	308	430	420
				2 to 1, .	-	-	-	-	366	-	-
15	Saylor's, . .	-	2,200	Neat, .	.2	6.2	18.0	161	479	127	214
				2 to 1, .	-	-	-	-	544	-	-
16	Lehigh, . .	-	5,160	Neat, .	.1	9.7	20.8	134	344	207	374
				2 to 1, .	-	-	-	-	515	-	-
	Total, . . .	-	106,888	Neat, .	.2	9.4	20.0	65	333	5,120	415
				2 to 1, .	-	-	-	-	420	-	-
	Natural cement: —										
17	Hoffman, . .	-	98,347	Neat, .	1.1	6.8	-	27	61	4,485	138
				1 to 1, .	-	-	-	26	63	-	-
18	Union, . . .	-	14,738	Neat, .	1.0	6.8	13.1	40	90	832	157
				1 to 1, .	-	-	-	27	73	-	-
	Total, . .	-	113,085	Neat, .	1.1	6.8	-	29	65	5,317	141
				1 to 1, .	-	-	-	26	64	-	-

and Other Works at the Wachusett Reservoir, 1901 to 1904, Inclusive.

TENSILE STRENGTH — Concluded.

Seven Days.		Twenty-eight Days.		Three Months.		Six Months.		Nine Months.		One Year.		Eighteen Months.		Two Years.		Three Years.		
Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	
47	1,021	5	1,026	5	1,029	5	1,091	5	1,063	5	1,015	5	1,029	5	1,034	-	-	1
47	474	5	428	5	445	5	405	5	452	5	406	5	340	5	320	-	-	
32	776	15	753	5	761	5	884	5	723	5	813	5	825	5	824	-	-	2
32	373	15	433	5	413	5	447	5	380	5	393	5	381	5	382	-	-	
206	837	167	848	20	801	20	848	20	823	20	899	20	873	15	833	-	-	3
207	384	167	450	20	444	20	445	20	459	20	422	20	404	15	393	-	-	
10	855	10	903	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
10	393	10	477	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
3,750	860	3,533	887	290	864	285	898	285	879	215	893	190	911	145	881	100	920	5
3,814	403	3,536	450	290	455	285	450	265	445	210	435	190	409	145	408	100	377	
23	843	23	933	5	906	5	881	5	872	5	897	5	870	5	896	-	-	6
23	301	23	409	5	377	5	380	5	402	5	386	5	389	5	372	-	-	
218	700	221	712	25	714	25	788	25	769	25	807	25	885	25	851	-	-	7
218	403	222	451	25	474	25	486	25	497	25	488	25	505	25	504	-	-	
959	871	591	879	20	897	15	907	15	927	15	898	5	1,074	5	1,060	-	-	8
959	396	591	499	20	447	15	481	15	426	15	456	5	426	5	447	-	-	
51	927	28	924	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
51	433	28	428	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
251	475	251	538	15	597	15	664	15	692	15	709	15	728	-	-	-	-	10
250	281	252	378	15	448	15	496	15	486	15	486	15	481	-	-	-	-	
20	946	13	970	5	996	5	971	5	874	5	1,047	-	-	-	-	-	-	11
20	434	13	478	5	474	5	445	5	431	5	352	-	-	-	-	-	-	
5,567	839	4,857	859	390	845	380	882	380	864	310	881	270	899	205	881	100	920	
5,631	396	4,862	452	390	453	380	453	360	449	305	489	270	419	205	416	100	377	
6,684	225	2,548	298	345	358	310	405	-	-	230	437	-	-	160	484	65	500	
6,664	185	2,540	278	345	411	310	490	-	-	230	553	-	-	160	624	65	660	12
1,360	116	1,307	197	275	290	230	382	-	-	170	421	-	-	94	461	-	-	

of the Weston Aqueduct, 1901 to 1904, Inclusive.

4,846	664	2,266	718	490	745	275	757	-	-	183	750	93	741	39	832	9	876	13
4,169	284	3,141	401	523	470	291	446	-	-	191	402	90	405	58	398	10	406	
481	659	228	707	98	762	82	764	-	-	66	759	25	808	12	835	-	-	14
405	323	268	402	102	482	89	476	-	-	91	449	23	433	15	436	-	-	
130	719	104	792	73	780	85	830	-	-	65	822	34	830	29	848	-	-	15
127	269	103	398	67	410	78	397	-	-	61	350	24	449	38	340	-	-	
210	639	169	730	64	744	49	765	-	-	48	769	20	827	10	971	-	-	16
208	314	166	455	68	491	49	490	-	-	50	418	20	433	10	434	-	-	
5,117	664	2,767	721	725	750	491	772	-	-	362	767	172	778	90	858	9	876	
4,909	288	3,678	403	760	468	507	448	-	-	393	418	157	419	121	388	10	406	
4,474	164	2,569	253	220	320	159	355	-	-	186	350	92	380	58	369	5	340	17
4,415	128	2,586	242	217	335	168	383	-	-	146	355	99	349	51	333	5	306	
833	205	409	269	63	312	52	356	-	-	32	394	25	402	15	404	-	-	18
833	174	431	246	69	345	51	395	-	-	30	467	20	501	15	541	-	-	
5,307	170	2,978	255	283	318	211	355	-	-	218	357	117	378	73	376	5	340	
5,248	186	3,017	242	286	338	219	386	-	-	176	374	119	374	66	380	5	305	

Appendix No. 3.

Table No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1904.*

	Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.	Princeton,	3.25	2.70	3.67	7.27	2.93	3.51	3.83	3.91	5.68	1.95	1.57	2.61	42.88
	Jefferson,	4.53	2.80	3.50	7.25	3.43	3.78	4.76	3.54	5.72	1.92	1.58	2.98	45.79
	Sterling,	3.50	2.43	3.22	6.93	3.02	3.54	3.14	3.59	5.22	1.70	1.61	2.87	40.77
	Boylston,	4.80	2.72	3.21	8.35	2.58	2.94	3.63	3.67	4.57	1.56	1.73	3.06	42.82
Sudbury Watershed.	Sudbury Dam,	4.64	2.86	2.57	8.38	2.84	3.36	2.24	4.32	4.80	1.58	1.68	2.80	42.07
	Framingham,	4.70	3.00	2.69	8.78	2.44	2.70	2.14	3.41	5.64	1.51	1.73	2.96	41.70
	Ashland Dam,	4.63	3.06	2.76	8.99	2.70	2.27	1.57	3.81	6.08	1.69	1.73	3.11	42.40
	Cordaville,	5.52	3.08	2.85	9.31	2.60	2.86	1.89	3.92	6.69	1.78	1.80	2.81	45.11
	Lake Cochituate,	4.75	3.11	2.78	8.68	2.14	2.86	1.80	3.32	6.78	1.66	1.84	2.39	42.11
	Chestnut Hill Reservoir,	5.64	2.96	2.79	9.18	3.28	2.75	1.48	2.74	5.75	2.21	1.81	2.81	43.40
	Spot Pond,	5.74	3.08	2.99	9.42	3.98	3.56	1.51	3.47	5.38	1.89	1.75	2.34	45.11
	Average of all,	4.70	2.89	3.00	8.41	2.90	3.10	2.55	3.61	5.67	1.77	1.71	2.80	43.11
	Average, Wachusett watershed,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
	Average, Sudbury watershed,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82

TABLE No. 2. — *Rainfall in Inches at Jefferson, Mass., in 1904.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.57†	0.90‡	-	-	0.50	*	-	-	-	-
2,	*	-	-	-	-	*	0.10	0.54	0.04	-	-	-
3,	0.85†	-	0.75‡	-	-	0.52	-	-	-	-	-	-
4,	-	-	-	-	-	-	-	-	-	-	-	-
5,	-	-	-	-	-	0.12	2.03	-	-	*	-	0.12†
6,	-	0.30†	-	-	-	*	-	-	-	0.22	-	-
7,	-	0.13	*	0.35	-	1.28	-	-	-	-	-	-
8,	*	-	1.00	-	-	-	-	0.27	*	0.08	-	0.03†
9,	0.30†	-	-	*	0.63	-	-	-	*	-	-	-
10,	-	-	-	1.21	*	-	-	*	0.37	-	-	-
11,	-	-	-	-	0.25	-	-	0.92	-	-	-	-
12,	-	-	-	0.21	-	-	-	-	-	0.40	-	*
13,	0.85‡	-	-	-	-	-	0.08	-	-	-	*	0.50†
14,	-	*	-	-	*	-	-	0.11	*	-	1.30‡	-
15,	-	0.28†	0.05†	-	0.15	-	-	-	4.09	-	-	-
16,	0.21†	-	-	0.35†	-	0.07	-	-	-	-	-	-
17,	-	-	-	-	*	-	-	-	-	-	-	*
18,	-	-	0.38†	-	*	-	0.75	-	-	-	-	0.38†
19,	-	0.20†	*	0.05†	0.63	-	-	-	-	-	-	-
20,	0.15†	-	0.15	-	0.25	-	-	1.70	-	-	-	-
21,	*	-	-	-	-	-	-	-	-	1.10	-	0.04†
22,	*	1.00	*	-	-	-	*	-	-	0.05	-	-
23,	1.25‡	-	0.15	-	-	-	*	-	-	-	-	-
24,	-	0.38†	-	-	-	-	*	-	0.23	-	-	-
25,	-	-	-	0.07	0.08	0.09	0.75	-	-	-	-	0.16†
26,	0.68†	-	-	*	0.52	-	-	-	0.13	0.07	-	*
27,	-	-	-	*	0.60	-	-	-	-	-	0.03†	*
28,	-	0.23‡	-	*	-	-	-	-	-	-	-	1.75‡
29,	*	0.28†	-	4.07	-	*	0.55	-	0.73	-	*	-
30,	0.24†	-	-	0.04	0.32	1.70	-	-	0.13	-	0.25	-
31,	-	-	0.45‡	-	-	-	-	-	-	-	-	-
Total,	4.53	2.80	3.50	7.25	3.43	3.78	4.76	3.54	5.72	1.92	1.58	2.98

Total for the year, 45.79 inches.

* Rainfall included in that of following day. † Snow. ‡ Rain and snow.

TABLE No. 3. — *Rainfall in Inches at Framingham, Mass., in 1904.*

Day of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.16†	0.98	0.01	-	0.04	*	-	-	-	-
2,	*	-	-	-	-	*	0.02	0.85	-	-	-	-
3,	1.26†	-	0.49‡	-	-	0.31	-	-	-	-	-	-
4,	-	-	-	-	-	-	-	-	0.02	-	-	-
5,	-	*	-	-	-	-	0.43	0.02	-	*	-	0.19†
6,	-	0.39‡	-	-	-	*	0.10	-	-	0.16	-	-
7,	-	0.05	0.79	0.18	-	0.57	-	-	-	-	-	-
8,	*	-	-	*	-	0.07	-	0.44	0.29	*	-	0.03†
9,	0.69†	-	-	0.60	0.88	-	-	-	0.06	0.02	0.02†	-
10,	-	-	-	1.22	0.08	-	-	0.45	-	0.03	-	-
11,	-	-	-	*	-	-	-	0.09	*	0.04	-	-
12,	-	-	-	0.28	-	-	-	-	0.60	*	-	*
13,	0.65‡	-	-	-	-	-	0.15	0.04	-	0.60	1.55‡	0.42†
14,	-	*	-	-	-	-	-	0.23	*	-	-	-
15,	-	0.50†	0.18†	*	0.32	-	-	-	3.66	-	-	-
16,	0.09‡	-	-	0.40†	-	-	0.05	0.18	-	-	-	-
17,	-	-	-	-	-	-	-	0.01	-	-	-	*
18,	-	-	0.41‡	-	0.35	-	-	-	-	-	-	0.47†
19,	-	0.20†	0.07	0.11‡	0.27	-	-	*	-	-	-	-
20,	0.06†	-	-	0.03†	0.02	-	-	1.10	-	*	0.03	-
21,	*	*	-	-	-	0.41	-	-	-	0.52	-	-
22,	*	0.84	0.01‡	-	-	-	*	-	-	-	-	-
23,	1.04‡	-	0.20	-	0.02	-	*	-	-	-	-	-
24,	-	0.35‡	-	0.08	-	-	*	-	0.14	-	-	-
25,	-	-	-	-	0.02	0.32	0.64	-	-	-	-	*
26,	0.67‡	-	-	*	0.03	-	0.54	-	0.06	0.14	-	0.12†
27,	-	-	-	*	0.26	-	-	-	-	-	0.04†	*
28,	-	0.16	-	*	-	-	-	-	-	-	-	1.73
29,	0.22†	0.51†	-	4.88	-	-	0.17	-	0.77	-	0.09	-
30,	-	-	-	0.02	0.18	1.02	-	-	0.04	-	-	-
31,	0.02	-	0.38‡	-	-	-	-	-	-	-	-	-
Total,	4.70	3.00	2.69	8.78	2.44	2.70	2.14	3.41	5.64	1.51	1.73	2.96

Total for the year, 41.70 inches.

* Rainfall included in that of following day. † Snow. ‡ Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1904.*

Date.	Amount.	Snow or Rain.	Duration.
Jan. 2,	1.15	Snow.	7.10 A.M. to
Jan. 3,			10.30 P.M.
Jan. 8,	1.09	Snow.	2.30 P.M. to
Jan. 9,			3.30 P.M.
Jan. 12,	0.08	Snow.	7.00 A.M. to 7.00 P.M.
Jan. 13,	1.18	Snow and rain.	11.00 A.M. to 10.45 P.M.
Jan. 16,	0.09	Snow.	3.20 P.M. to 6.15 P.M.
Jan. 20,	0.08	Snow.	5.50 A.M. to 11.30 A.M.
Jan. 21,	1.04	Snow and rain.	2.45 P.M. to
Jan. 22,			10.40 P.M.
Jan. 23,	0.10	Rain.	1.45 P.M. to 6.30 P.M.
Jan. 26,	0.73	Rain and snow.	3.45 P.M. to 10.50 P.M.
Jan. 29,	0.15	Snow.	5.50 A.M. to 8.00 P.M.
Total,	5.64		
Feb. 6,	0.46	Snow and rain.	1.00 A.M. to 9.00 P.M.
Feb. 14,	0.77	Snow.	7.00 P.M. to
Feb. 15,			5.30 P.M.
Feb. 19,	0.21	Snow.	6.10 A.M. to 5.45 P.M.
Feb. 21,	0.98	Rain.	11.23 P.M. to
Feb. 22,			1.45 P.M.
Feb. 24,	0.33	Snow.	4.30 A.M. to 3.30 P.M.
Feb. 28,	0.15	Rain.	2.00 P.M. to 4.30 P.M.
Mar. 1,	0.06	Rain and snow.	1.00 A.M. to 7.00 A.M.
Total,	2.96		
Mar. 1,	0.15	Snow.	7.00 A.M. to 4.30 P.M.
Mar. 3,	0.47	Rain.	5.00 A.M. to 8.15 P.M.
Mar. 7,	0.96	Rain.	5.45 P.M. to
Mar. 8,			4.30 A.M.
Mar. 15,	0.14	Snow.	5.50 A.M. to 8.00 P.M.
Mar. 18,	0.40	Snow and rain.	5.50 A.M. to 5.30 P.M.
Mar. 19,	0.07	Rain.	8.30 P.M. to
Mar. 20,			12.20 A.M.
Mar. 22,	0.27	Snow and rain.	6.05 A.M. to
Mar. 23,			9.45 A.M.
Mar. 31,	0.33	Snow and rain.	5.35 P.M. to
Apr. 1,			7.00 A.M.
Total,	2.79		
Apr. 1,	1.01	Rain.	9.00 A.M. to 6.10 P.M.
Apr. 7,	0.17	Rain.	7.50 A.M. to 1.20 P.M.
Apr. 8,	1.42	Rain.*	9.25 P.M. to
Apr. 10,			3.05 A.M.
Apr. 11,	0.06	Rain.	3.20 A.M. to 5.05 A.M.
Apr. 12,	0.32	Rain.	5.00 A.M. to 10.45 A.M.
Apr. 16,	0.38	Snow.	2.10 A.M. to 12.30 P.M.
Apr. 19,	0.25	Snow.	5.15 P.M. to 11.20 P.M.
Apr. 24,	0.10	Rain.	2.15 A.M. to 5.45 A.M.
Apr. 26,	0.10	Rain.	9.30 P.M. to 7.00 A.M.
Apr. 27,	5.37	Rain.*	7.00 A.M. to
Apr. 30,			6.30 P.M.
Total,	9.18		
May 9,	0.79	Rain.	6.10 A.M. to 8.00 P.M.
May 10,	0.14	Rain.	5.20 P.M. to 6.30 P.M.
May 15,	0.24	Rain.	7.00 P.M. to 10.30 P.M.
May 18,	1.15	Rain.*	9.30 A.M. to
May 20,			1.30 P.M.
May 25,	0.28	Rain.*	7.00 P.M. to 8.45 P.M.
May 27,	0.40	Rain.*	1.10 P.M. to 1.40 P.M.
May 30,	0.28	Rain.	2.40 P.M. to 9.30 P.M.
Total,	3.28		
June 2,	0.57	Rain.	12.25 P.M. to 7.00 P.M.
June 7,	0.50	Rain.*	3.15 A.M. to 7.30 A.M.
June 7,	0.05	Rain.	10.00 P.M. to
June 8,			2.00 A.M.
June 21,	0.20	Rain.*	1.20 P.M. to 1.40 P.M.
June 21,	0.10	Rain.	4.00 P.M. to
June 23,			12.45 A.M.
June 25,	0.30	Rain.*	6.30 P.M. to 9.00 P.M.
June 26,	0.18	Rain.*	1.30 P.M. to 2.40 P.M.
June 28,	0.85	Rain.	11.05 P.M. to
June 30,			11.45 P.M.
Total,	2.75		
July 1,	0.02	Rain.	7.00 A.M. to 8.30 A.M.
July 5,	0.44	Rain.	4.20 P.M. to 9.50 P.M.
July 13,	0.09	Rain.	5.55 A.M. to 11.40 A.M.
July 17,	0.19	Rain.	7.30 P.M. to 9.00 P.M.
July 22,	0.61	Rain.	8.30 P.M. to
July 25,			1.30 A.M.
July 27,	0.06	Rain.	2.00 A.M. to 6.00 A.M.
July 29,	0.07	Rain.	2.25 A.M. to 3.35 A.M.
Total,	1.48		
Aug. 1,	0.96	Rain.	6.25 P.M. to
Aug. 3,			8.00 A.M.
Aug. 6,	0.19	Rain.	12.30 A.M. to 4.15 A.M.
Aug. 8,	0.03	Rain.	6.50 A.M. to 8.30 A.M.
Aug. 11,	0.41	Rain.	5.50 P.M. to 5.55 P.M.
Aug. 14,	0.08	Rain.	1.05 A.M. to 3.00 P.M.
Aug. 16,	0.04	Rain.	3.30 P.M. to 6.00 P.M.
Aug. 20,	1.03	Rain.	5.00 A.M. to
Aug. 21,			2.30 A.M.
Total,	2.74		
Sept. 4,	0.02	Rain.	2.35 A.M. to 3.25 A.M.
Sept. 8,	0.28	Rain.	7.00 P.M. to
Sept. 10,			12.15 A.M.
Sept. 11,	0.51	Rain.	11.45 P.M. to
Sept. 12,			9.10 P.M.
Sept. 14,	3.84	Rain.	11.10 A.M. to
Sept. 15,			8.30 A.M.
Sept. 24,	0.30	Rain.	8.30 P.M. to
Sept. 26,			6.15 P.M.
Sept. 29,	0.80	Rain.	12.45 P.M. to
Sept. 30,			1.15 P.M.
Total,	5.75		

* Thunder shower.

TABLE NO. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1904* — Concluded.

Date.	Amount.	Snow or Rain.	Duration.	Date.	Amount.	Snow or Rain.	Duration.
Oct. 5,	0.32	Rain.	9.15 P.M. to 11.20 P.M.	Dec. 5,	0.21	Snow.	5.00 P.M. to 11.05 P.M.
Oct. 9,	0.02	Rain.	12.50 A.M. to 2.25 A.M.	Dec. 8,	0.06	Snow.	10.00 A.M. to 6.00 P.M.
Oct. 11,	0.14	Rain.	3.30 A.M. to 4.30 P.M.	Dec. 12, Dec. 13,	0.15	Snow.	6.00 P.M. to 6.30 A.M.
Oct. 12, Oct. 13,	0.92	Rain.	1.20 P.M. to 3.30 A.M.	Dec. 16, Dec. 18,	0.71	Snow.	1.55 A.M. to 10.30 A.M.
Oct. 21,	0.64	Rain.	12.55 A.M. to 2.45 P.M.	Dec. 26, Dec. 28,	1.68	Snow and rain.	11.45 P.M. to 10.00 A.M.
Oct. 26,	0.17	Rain.	11.15 A.M. to 5.15 P.M.				
Total,	2.21			Total,	2.81		
Nov. 13, Nov. 14,	1.66	Rain.	8.30 A.M. to 5.00 A.M.				
Nov. 21,	0.05	Rain.	2.55 A.M. to 5.10 A.M.				
Nov. 29, Nov. 30,	0.10	Rain.	8.00 P.M. to 1.25 A.M.				
Total,	1.81						

Total for the year, 43.40 inches.

TABLE NO. 5. — *Rainfall in Inches on the Wachusett Watershed, 1897 to 1904.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897,	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898,	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899,	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900,	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901,	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902,	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903,	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
Total,	28.94	33.09	40.29	36.00	27.60	35.15	35.48	36.55	28.24	30.04	30.15	39.01	400.54
Average,	3.62	4.14	5.04	4.50	3.45	4.39	4.43	4.57	3.53	3.75	3.77	4.88	50.07

NOTE. — The figures tabulated are means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1904, Princeton, Jefferson, Sterling and Boylston.

TABLE NO. 6. — *Rainfall in Inches on the Sudbury Watershed,* 1875 to 1904.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.84	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.08	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.08	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.98	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.86	3.83	5.70	2.74	50.65
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.88	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.78	2.92	42.82
Total,	126.19	130.14	137.79	108.25	100.32	92.58	110.11	121.66	99.58	126.76	118.70	114.46	1,386.54
Average,	4.21	4.34	4.59	3.61	3.34	3.09	3.67	4.05	3.32	4.23	3.96	3.81	46.22

* Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1904, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE NO. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile* from 1897 to 1904.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Mean for 8 Years, 1897-1904.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,171,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	1,563,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,186,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	2,623,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	1,328,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	929,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	530,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	536,000
September,	330,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	358,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	614,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	861,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,593,000
Average for year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	1,273,000
Average for driest 6 months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	637,000

* The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, and to 3.6 per cent. in 1904.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile * from 1875 to 1904.*

Month	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
January,	108,000	648,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000
October,	646,000	284,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	88,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000
Average for year,	972,000	1,185,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	588,000	1,129,000
Average for driest 6 months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000

* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile* from 1875 to 1904* — Continued.

MONTH.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
January,	1,235,000	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	698,000
February,	1,354,000	4,801,000	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000
March,	1,572,000	2,059,000	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000
April,	1,815,000	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000
May,	1,336,000	720,000	1,009,000	1,632,000	880,000	1,866,000	583,000	1,259,000	2,883,000	840,000
June,	426,000	203,000	418,000	421,000	653,000	568,000	418,000	428,000	440,000	419,000
July,	62,000	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000
August,	240,000	94,000	214,000	379,000	1,482,000	132,000	163,000	280,000	181,000	209,000
September,	121,000	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000
October,	336,000	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000
November,	1,177,000	673,000	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000
December,	1,174,000	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000
Average for year,	901,000	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000
Average for driest 6 months,	391,000	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000

* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile* from 1875 to 1904* — Concluded.

MONTH.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Mean for 30 Years, 1875-1904.
January,	1,084,000	1,084,000	845,000	1,688,000	2,288,000	794,000	487,000	1,763,000	1,736,000	477,000	1,217,000
February,	541,000	2,676,000	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	1,861,000
March,	2,410,000	3,835,000	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,986,000
April,	2,515,000	1,494,000	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	2,116,000
May,	636,000	360,000	915,000	1,246,000	511,000	1,312,000	2,954,000	748,000	351,000	1,745,000	1,141,000
June,	174,000	399,000	962,000	530,000	66,000	316,000	753,000	808,000	1,987,000	419,000	522,000
July,	231,000	95,000	658,000	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	198,000
August,	229,000	57,000	591,000	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	291,000
September,	89,000	388,000	182,000	369,000	94,000	65,000	305,000	178,000	130,000	397,000	238,000
October,	1,379,000	592,000	94,000	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	506,000
November,	2,777,000	659,000	909,000	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	868,000
December,	1,782,000	657,000	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	1,062,000
Average for year,	1,152,000	1,019,000	991,000	1,450,000	978,000	1,082,000	1,342,000	1,140,000	1,190,000	981,000	1,081,000
Average for driest six months,	460,000	314,000	564,000	777,000	93,000	194,000	445,000	271,000	388,000	228,000	435,000

* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 9. — *Wachusett System.* — *Statistics of Flow of Water, Storage and Rainfall in 1904.*

[Watershed=119.00 square miles.]

MONTH.	Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day).*	Quantity of Water wasted into River below Dam (Gallons per Day).	STORAGE.† Gain (Gallons per Day).	STORAGE.† Loss (Gallons per Day).	Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
January,	87,365,000	2,487,000	-	11,341,000	78,471,000	4.02	1.176	29.3
February,	117,266,000	2,624,000	-	9,590,000	110,300,000	2.66	1.547	58.1
March,	107,806,000	5,136,000	244,955,000	-	357,897,000	3.40	5.361	157.7
April,	95,060,000	202,727,000	57,350,000	-	355,137,000	7.45	5.149	69.1
May,	106,868,000	73,719,000	-	2,377,000	178,210,000	2.99	2.671	89.3
June,	105,410,000	16,537,000	-	31,287,000	90,660,000	3.44	1.315	38.2
July,	110,287,000	2,061,000	-	53,235,000	59,113,000	3.84	0.886	23.1
August,	78,390,000	2,300,000	-	38,461,000	42,229,000	3.68	0.633	17.2
September,	54,367,000	2,123,000	2,300,000	-	58,790,000	5.30	0.853	16.1
October,	28,361,000	2,181,000	10,810,000	-	41,352,000	1.78	0.620	34.8
November,	46,103,000	2,377,000	-	7,717,000	40,763,000	1.62	0.591	29.0
December,	125,803,000	1,929,000	-	75,426,000	52,306,000	2.88	0.784	27.2
Total,	-	-	-	-	-	43.06	21.586	-
Average for year,	88,580,000	26,156,000	7,275,000	-	122,011,000	-	-	50.2

* Including small quantities wasted in cleaning aqueduct.

† Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1904.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1904 inclusive = 75.2 square miles.]

MONTH.	Quantity of Water received through Wachusett Aqueduct (Gallons per Day).*	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).†	Quantity of Water discharged through Weston Aqueduct (Gallons per Day).†	Quantity of Water used by Framingham Water Company (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE. Gain (Gallons per Day).	STORAGE. Loss (Gallons per Day).	Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
January,	87,365,000	85,806,000	32,852,000	619,000	710,000	23,703,000	-	19,912,000	35,884,000	4.87	0.851	17.5
February,	117,266,000	86,604,000	33,276,000	631,000	1,069,000	46,590,000	15,441,000	-	66,345,000	3.00	1.472	49.0
March,	107,806,000	70,442,000	32,323,000	529,000	1,984,000	131,958,000	96,081,000	-	225,510,000	2.72	5.349	196.8
April,	95,060,000	98,278,000	15,430,000	510,000	2,270,000	198,637,000	32,610,000	-	247,690,000	8.87	5.685	64.0
May,	106,868,000	85,077,000	30,452,000	548,000	1,736,000	112,997,000	7,258,000	-	181,200,000	2.65	3.112	117.7
June,	105,410,000	85,783,000	28,040,000	550,000	770,000	27,887,000	-	6,133,000	31,487,000	2.80	0.723	25.8
July,	110,287,000	73,061,000	33,216,000	564,000	429,000	10,355,000	-	2,703,000	4,655,000	1.96	0.111	5.6
August,	78,390,000	58,384,000	34,194,000	516,000	403,000	13,468,000	-	15,823,000	12,752,000	3.86	0.303	7.8
September,	54,367,000	68,280,000	35,293,000	523,000	340,000	1,523,000	-	21,760,000	29,833,000	5.80	0.685	11.8
October,	28,361,000	63,755,000	36,868,000	545,000	297,000	1,500,000	-	60,245,000	14,358,000	1.64	0.348	21.2
November,	45,790,000	62,007,000	33,403,000	533,000	230,000	2,507,000	-	31,157,000	21,733,000	1.73	0.499	28.8
December,	125,803,000	93,403,000	30,626,000	565,000	323,000	1,500,000	19,642,000	-	20,255,000	2.92	0.481	16.5
Total,	-	-	-	-	-	-	-	-	-	42.82	19.619	-
Av. for year,	88,554,000	77,104,000	31,316,000	553,000	879,000	47,616,000	1,112,000	-	70,025,000	-	-	45.8

* Not including quantities of water wasted in cleaning aqueduct, which were not discharged into Sudbury Reservoir.

† Including quantities of water wasted from aqueduct.

TABLE NO. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1904.*

[Watershed of lake = 18.87 square miles.*]

MONTH.	Quantity of Water received from External Sources (Gallons per Day).†	Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted at Outlet (Gallons per Day).	STORAGE. Gain (Gallons per Day).	STORAGE. Loss (Gallons per Day).	Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
January,	-	21,165,000	419,000	-	-	10,490,000	11,094,000	4.75	1.05	22.1
February,	-	21,248,000	545,000	-	-	7,566,000	14,228,000	3.11	1.26	40.5
March,	-	18,974,000	506,000	1,523,000	29,108,000	-	50,106,000	2.78	4.73	170.4
April,	-	7,820,000	1,463,000	47,887,000	87,000	-	57,257,000	8.68	5.24	60.4
May,	129,000	2,322,000	1,268,000	18,006,000	3,310,000	-	24,777,000	2.14	2.34	109.5
June,	80,000	-	567,000	4,520,000	953,000	-	5,960,000	2.86	0.55	19.1
July,	-	6,439,000	297,000	-	-	6,013,000	723,000	1.80	0.07	3.8
August,	-	20,552,000	287,000	-	-	15,981,000	4,858,000	3.32	0.49	14.8
September,	9,200,000	28,187,000	340,000	-	-	8,843,000	10,983,000	6.78	1.00	14.8
October,	24,690,000	23,797,000	332,000	-	5,006,000	-	4,445,000	1.66	0.42	25.3
November,	3,647,000	22,967,000	300,000	-	-	10,877,000	9,243,000	1.84	0.85	46.0
December,	-	11,777,000	290,000	-	-	3,555,000	8,581,000	2.39	0.80	33.7
Total,	-	-	-	-	-	-	-	42.11	18.80	-
Average for year,	3,162,000	15,003,000	550,000	5,950,000	-	1,522,000	16,819,000	-	-	44.6

* Not including the watershed of Dudley Pond.

† From Framingham reservoirs, Nos. 1, 2 and 3.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

Date.	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Farm Pond. High Water =159.25.	Spot Pond. High Water =163.00.	Framingham Reservoir No. 1. Flash Boards 169.27.	Framingham Reservoir No. 2 Flash Boards 177.12.	Framingham Reservoir No. 3. Flash Boards 186.50.	Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water =337.91.	Wachusett Reservoir.
Jan. 1, 1904,	133.17	142.42	158.59	162.26	167.70	175.97	183.37	220.90	252.63	299.84	337.89	305.90
Feb. 1, 1904,	132.99	140.94	158.55	162.89	167.78	176.09	183.36	221.56	250.94	301.22	337.17	303.39
March 1, 1904,	132.78	139.90	158.57	162.24	167.90	176.20	183.44	221.25	252.53	301.53	336.47	301.30
April 1, 1904,	132.89	143.92	158.84	162.62	167.95	176.24	183.93	224.16	258.65	303.63	337.54	327.78
May 1, 1904,	133.45	143.93	159.46	163.32	168.61	177.41	184.98	225.01	259.52	305.12	338.96	330.96
June 1, 1904,	133.97	144.33	159.23	162.87	169.49	177.29	186.01	225.32	259.96	305.05	338.56	331.46
July 1, 1904,	134.17	144.44	158.88	163.21	169.43	177.22	185.40	225.23	259.65	305.04	338.69	330.00
Aug. 1, 1904,	133.06	143.71	158.39	163.08	169.30	177.12	185.05	224.99	259.76	304.78	338.51	326.58
Sept. 1, 1904,	132.16	141.56	158.13	163.10	167.87	175.42	184.95	223.81	259.14	304.83	338.46	323.91
Oct. 1, 1904,	133.94	141.10	158.56	163.58	167.47	177.61	185.08	219.70	258.57	300.44	338.24	324.07
Nov. 1, 1904,	132.17	141.81	158.25	161.49	168.27	176.46	185.04	213.74	255.96	298.17	337.74	324.89
Dec. 1, 1904,	132.04	140.37	158.10	162.91	164.92	176.90	184.23	205.67	255.52	286.46	337.90	324.28
Jan. 1, 1905,	133.98	139.84	158.14	163.57	166.65	177.09	184.25	193.87	259.18	273.52	336.74	317.00

TABLE No. 13. — *Average Daily Quantity of Water flowing through Aqueducts in 1904, by Months.**

Month.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir.			Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
			From Framingham Reservoir No. 3 (Gallons).	From Framingham Reservoir No. 2 (Gallons).	Total (Gallons).	
January,	87,365,000	32,010,000	85,806,000	-	85,806,000	21,165,000
February,	117,265,000	33,042,000	86,604,000	-	86,604,000	21,248,000
March,	107,806,000	33,048,000	70,442,000	-	70,442,000	18,974,000
April,	95,060,000	8,068,000	93,273,000	-	93,273,000	7,290,000
May,	106,868,000	30,907,000	83,713,000	-	83,713,000	2,290,000
June,	105,343,000	28,036,000	85,673,000	-	85,673,000	-
July,	110,287,000	33,017,000	73,081,000	-	73,081,000	6,439,000
August,	78,390,000	33,044,000	56,207,000	2,177,000	58,384,000	20,552,000
September,	54,367,000	34,405,000	36,250,000	22,797,000	59,047,000	23,187,000
October,	28,361,000	36,020,000	25,787,000	13,258,000	39,045,000	23,797,000
November,	45,790,000	32,489,000	27,100,000	31,260,000	58,360,000	22,967,000
December,	125,803,000	32,352,000	54,845,000	38,558,000	93,403,000	11,777,000
Average,	88,554,000	30,575,000	64,827,000	9,004,000	73,831,000	14,984,000

* Not including quantities wasted while cleaning and repairing aqueducts and the Weston Reservoir, and not including 3,162,000 gallons per day diverted through the Sudbury Aqueduct to Lake Cochituate.

TABLE No. 14. — *Statement of Operations of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1904.*

Allowed for slip: Engine No. 1, 13.36 per cent. January to August, inclusive. Engine No. 1, 11.29 per cent. September to December, inclusive. Engine No. 2, 3.81 per cent.

MONTH.	ENGINE NO 1.		ENGINE NO. 2.		Total Amount pumped (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).								
	Hrs. Min.		Hrs. Min.									
January,	249 -	94.60	- -	-	94.60	178,344	17,346	10.0	545.74	120.58	54,820,000	63,360,000
February,	285 05	109.09	- -	-	109.09	255,017	26,552	10.4	427.78	121.40	43,260,000	50,000,000
March,	64 20	25.55	- -	-	25.55	94,527	12,443	13.2	270.29	121.11	27,270,000	31,520,000
April,	- -	-	- -	-	-	-	-	-	-	-	-	-
May,	66 10	25.81	- -	-	25.81	40,459	3,794	9.4	637.93	120.67	64,120,000	74,100,000
June,	87 05	33.24	- -	-	33.24	47,480	6,110	12.9	700.08	119.36	69,610,000	80,450,000
July,	138 15	55.21	- -	-	55.21	78,873	9,425	11.9	700.00	119.30	69,560,000	80,390,000
August,	68 45	25.22	- -	-	25.22	36,169	4,457	12.3	697.28	120.46	69,970,000	80,860,000
September,	93 10	38.42	- -	-	38.42	53,452	6,473	12.1	718.78	120.98	72,440,000	81,540,000
October,	10 25	4.42	- -	-	4.42	6,155	700	11.4	718.12	121.55	72,710,000	81,850,000
November,	191 45	80.67	- -	-	80.67	112,244	12,235	10.9	718.70	121.27	72,600,000	81,720,000
December,	214 55	81.19	7 30	2.78	83.97	115,182	13,387	11.6	727.46	120.56	73,060,000	82,240,000
Total and average,	1,463 55	573.42	7 30	2.78	576.20	1,012,902	112,922	11.1	568.12	120.69	57,120,000	65,400,000

During December, 1,000,000 gallons of the water pumped by Engine No. 1 were diverted to low service, and Engine No. 2 was run to ascertain its condition. The work of Engine No. 2 does not enter into the other calculations for the month.

TABLE NO. 15. — *Statement of Operations of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1904.*

[7.5 per cent. allowed for slip.]

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
January,	-	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-	-
March,	-	-	-	-	-	-	-	-	-	-
April,	-	-	-	-	-	-	-	-	-	-
May,	51	15	48.16	47,207	5,107	10.8	1,020.19	126.29	107,320,000	115,960,000
June,	-	-	-	-	-	-	-	-	-	-
July,	48	25	45.52	41,150	4,853	11.8	1,106.20	128.10	118,040,000	127,540,000
August,	-	-	-	-	-	-	-	-	-	-
September,	-	-	-	-	-	-	-	-	-	-
October,	-	-	-	-	-	-	-	-	-	-
November,	211	50	199.18	191,319	22,014	11.5	1,041.09	128.25	111,220,000	120,170,000
December,	-	-	-	-	-	-	-	-	-	-
Total and average,	311	30	292.86	279,676	31,974	11.4	1,047.14	127.90	111,560,000	120,540,000

TABLE NO. 16. — *Statement of Operations of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1904.*

[3 per cent. allowed for slip.]

Month.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	Summary for Engines Nos. 1, 2, 3 and 4. Total Amount pumped, corrected for Slip (Million Gallons).	Summary for Engines Nos. 1, 2, 3 and 4. Daily Average Amount pumped (Million Gallons).
January,	742	45	928.05	766,320	77,866	10.2	1,204.52	127.77	128,200,000	132,140,000	1,017.65	32.827
February,	690	40	864.90	704,608	76,109	10.8	1,227.49	130.23	133,160,000	137,250,000	973.99	33.585
March,	740	15	925.93	812,210	113,841	14.0	1,140.01	129.89	122,870,000	126,650,000	951.48	30.693
April,	720	-	864.05	703,306	81,594	11.6	1,228.55	128.38	131,380,000	135,420,000	864.05	28.802
May,	690	30	840.95	680,711	91,051	13.4	1,235.40	128.96	132,710,000	136,790,000	914.92	29.514
June,	716	20	872.20	706,734	100,898	14.3	1,234.13	128.08	131,670,000	135,720,000	905.44	30.181
July,	694	40	862.40	700,638	97,760	14.0	1,230.88	129.30	132,570,000	136,650,000	963.18	31.069
August,	742	50	923.95	758,412	105,924	14.0	1,218.27	129.09	131,000,000	135,030,000	949.17	30.618
September,	717	-	913.93	731,551	96,372	13.2	1,249.30	130.18	135,470,000	139,640,000	952.35	31.745
October,	744	-	950.78	783,148	97,725	12.5	1,214.06	130.63	132,110,000	136,170,000	955.20	30.813
November,	505	55	632.76	533,668	67,482	12.6	1,185.68	130.11	128,510,000	132,460,000	912.61	30.420
December,	744	-	947.85	775,431	86,235	11.1	1,222.35	129.63	131,990,000	136,050,000	1,031.82	33.285
Total and average,	8,448	55	10,522.75	8,656,737	1,092,857	12.6	1,215.56	129.30	130,920,000	134,950,000	11,391.81	31.125

TABLE No. 17. — *Statement of Operations of Engines Nos. 5, 6 and 7 at Chestnut Hill Low-service Pumping Station for the Year 1904.*

[3 per cent. allowed for slip.]

Month.	Engine No. 5.		Engine No. 6.		Engine No 7.							Average Lift (Feet).				
	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons)	Total Amount pumped (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Total Amount of Coal consumed (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Engine No. 5.	Engine No. 6.	Engine No. 7.	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs. Min.		Hrs. Min.		Hrs. Min.											
January,	691 15	823.60	703 15	848.18	444 55	508.86	2,180.64	70.343	923,732	10.8	2,360.68	59.61	59.65	60.90	117,840,000	121,430,000
February,	615 15	705.01	613 35	705.81	543 25	621.68	2,032.50	70.086	923,338	11.4	2,201.25	62.20	62.34	62.84	114,220,000	117,700,000
March,	381 10	353.39	644 25	698.56	652 30	700.89	1,752.84	56.543	757,345	11.7	2,314.45	59.46	56.16	56.70	109,970,000	113,320,000
April,	579 35	715.42	447 50	551.22	661 05	808.98	2,075.62	69.187	763,690	11.3	2,717.88	50.56	51.03	49.84	114,110,000	117,590,000
May,	711 -	808.90	394 25	460.08	376 25	422.99	1,691.97	54.580	684,815	13.0	2,470.70	53.19	52.49	52.94	108,950,000	112,270,000
June,	575 20	619.83	653 20	703.46	218 05	245.16	1,568.45	52.282	655,122	12.6	2,394.13	53.99	53.62	55.51	107,820,000	111,110,000
July,	688 50	671.13	442 45	436.11	338 -	338.15	1,445.39	46.625	595,016	14.0	2,429.16	51.85	50.65	53.47	104,950,000	108,150,000
August,	664 45	694.51	383 10	370.12	314 45	366.94	1,431.57	46.180	584,585	13.6	2,448.87	49.76	49.93	48.95	101,170,000	104,260,000
September,	336 -	410.36	229 -	274.22	607 -	733.80	1,418.38	47.279	648,670	12.9	2,186.60	53.88	56.98	52.46	97,890,000	100,880,000
October,	424 10	473.94	178 45	202.47	354 10	420.41	1,096.82	35.381	490,163	10.7	2,237.66	48.59	56.59	57.61	95,740,000	98,660,000
November,	489 20	635.53	529 30	692.97	140 15	184.30	1,512.80	50.427	671,885	10.8	2,251.58	52.60	51.55	48.21	95,610,000	98,530,000
December,	550 50	692.55	668 20	835.44	449 20	533.97	2,061.96	66.515	964,507	11.8	2,137.84	58.79	58.12	59.72	104,640,000	107,830,000
Total and average,	6,657 30	7,604.17	5,888 20	6,778.64	5,094 55	5,886.13	20,268.94	55.380	8,662,868	12.0	2,339.75	54.30	55.43	55.12	107,030,000	110,290,000

TABLE No. 18. — *Statement of Operations of Engine No. 9 at Spot Pond Pumping Station for the Year 1904.*

[3 per cent. allowed for slip.]

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
January,	317	-	259.07	8.357	241,736	40,347	16.7	1,071.71	129.50	115,610,000	119,230,000
February,	327	35	262.15	9.040	231,875	35,220	15.2	1,130.57	129.06	121,540,000	125,350,000
March,	293	05	233.54	7.534	197,973	32,508	16.4	1,179.66	129.44	127,200,000	131,190,000
April,	274	20	214.54	7.151	179,280	28,281	15.8	1,196.68	129.66	129,250,000	133,300,000
May,	300	15	232.20	7.490	193,901	30,861	15.9	1,197.52	129.56	129,240,000	133,290,000
June,	315	20	249.23	8.308	202,014	29,360	14.5	1,233.73	129.30	132,880,000	137,040,000
July,	346	40	277.94	8.966	217,213	27,467	12.6	1,279.57	128.16	136,600,000	140,880,000
August,	338	45	273.01	8.807	213,004	25,628	12.0	1,281.71	128.15	136,820,000	141,110,000
September,	324	10	260.40	8.680	206,187	23,509	11.4	1,262.93	128.93	135,640,000	139,890,000
October,	285	45	228.17	7.360	188,254	22,836	12.1	1,212.08	131.50	132,770,000	136,930,000
November,	259	55	206.43	6.881	177,533	20,691	11.7	1,162.77	129.98	125,850,000	129,790,000
December,	292	10	230.79	7.445	213,832	26,174	12.2	1,079.30	129.36	116,300,000	119,940,000
Total and average,	3,675	-	2,927.47	7.999	2,462,802	342,877	13.9	1,188.67	129.33	128,060,000	132,070,000

TABLE No. 19. — *Average Daily Consumption of Water, during the Year 1904, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont, Nahant and a Small Portion of Saugus. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 23.)*

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	134,479,000	917,300	147
February,	139,941,000	919,100	152
March,	120,392,000	920,900	131
April,	105,800,000	922,700	115
May,	108,450,000	924,500	117
June,	107,825,000	926,600	116
July,	110,096,000	928,600	119
August,	109,477,000	930,700	118
September,	110,866,000	932,700	119
October,	105,220,000	934,800	113
November,	105,034,000	936,800	112
December,	121,986,000	938,900	130
For the year,	114,909,000	927,800	124

TABLE No. 20. — *Average Daily Consumption of Water, in Gallons, from the Low Service System (1904).*

MONTH.	SOUTHERN LOW SERVICE. Boston, excluding East Boston and Charlestown.	NORTHERN LOW SERVICE. Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	Total Low Service Consumption.
January,	57,242,000	35,627,000	92,869,000
February,	58,976,000	37,783,000	96,759,000
March,	52,165,000	29,519,000	81,684,000
April,	45,164,000	24,347,000	69,511,000
May,	45,691,000	25,158,000	70,849,000
June,	44,398,000	24,547,000	68,945,000
July,	44,547,000	24,789,000	69,336,000
August,	44,954,000	24,388,000	69,342,000
September,	43,963,000	26,076,000	70,039,000
October,	41,958,000	24,659,000	66,617,000
November,	43,162,000	23,991,000	67,153,000
December,	50,168,000	30,715,000	80,883,000
For the year,	47,676,000	27,609,000	75,285,000

TABLE NO. 21. — *Average Daily Consumption of Water, in Gallons, from the High Service and Extra High Service Systems (1904).*

Month.	Southern High Service. Quincy, Watertown, Belmont, and Portions of Boston and Milton.	Southern Extra High Service. Portions of Boston and Milton.	Northern High Service. Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford, Somerville and Saugus.	Northern Extra High Service. Lexington and Portion of Arlington.
January,	32,344,000	447,000	8,339,000	480,000
February,	33,155,000	458,000	9,072,000	497,000
March,	30,256,000	432,000	7,542,000	478,000
April,	28,372,000	421,000	7,049,000	447,000
May,	29,092,000	491,000	7,508,000	510,000
June,	29,478,000	525,000	8,300,000	577,000
July,	30,522,000	600,000	9,018,000	620,000
August,	30,176,000	548,000	8,846,000	565,000
September,	31,143,000	571,000	8,554,000	559,000
October,	30,228,000	517,000	7,348,000	510,000
November,	30,030,000	499,000	6,886,000	466,000
December,	32,576,000	536,000	7,492,000	499,000
For the year,	30,610,000	504,000	7,993,000	517,000

TABLE No. 22. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters — 1904.*

City or town,	BOSTON.		SOMERVILLE.		MALDEN.		CHELSEA.		EVERETT.		QUINCY.		MEDFORD.	
Population supplied,	611,830.		70,320.		40,825.		37,835.		29,370.		27,830.		22,125.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day	Per Capita.	Per Day	Per Capita.	Per Day.	Per Capita.
January,	103,119,400	170	7,834,500	113	1,965,000	50	6,268,200	169	3,311,600	115	2,730,700	100	1,868,800	86
February,	105,446,600	174	8,175,300	118	2,020,600	50	6,613,200	177	3,428,600	119	2,807,800	102	1,957,300	90
March,	93,957,200	154	6,456,500	93	1,849,600	46	5,152,500	138	2,847,000	98	2,850,400	103	1,721,200	79
April,	81,915,100	134	5,606,200	80	1,705,200	42	3,750,300	100	2,594,300	89	2,626,800	95	1,567,700	72
May,	83,275,300	136	5,757,800	82	1,898,000	47	3,685,200	98	2,453,500	84	2,617,900	95	1,698,900	77
June,	81,448,100	133	5,858,500	83	1,997,800	49	3,535,300	93	2,438,600	83	2,898,500	104	1,895,300	86
July,	82,777,800	135	6,058,300	86	1,989,000	48	3,594,400	95	2,471,000	84	3,142,900	113	2,020,900	91
August,	82,835,300	135	5,796,700	82	2,004,900	49	3,598,600	95	2,269,600	77	3,052,200	109	1,923,900	86
September,	83,896,700	137	5,741,300	81	1,877,200	45	3,521,600	92	2,285,800	77	3,055,100	109	1,901,900	85
October,	80,221,400	130	5,226,000	74	1,666,700	40	3,268,700	85	2,247,100	76	2,748,500	98	1,706,900	76
November,	80,748,500	131	5,234,600	73	1,662,400	40	3,347,900	88	2,342,900	78	2,606,100	92	1,688,400	75
December,	92,935,200	151	7,042,000	99	1,785,400	43	4,854,300	127	2,826,600	94	2,742,600	97	1,692,100	75
For the year,	87,680,300	143	6,228,300	89	1,868,000	46	4,260,500	113	2,624,400	89	2,823,200	101	1,802,900	81

TABLE No. 22. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	Melrose.		Revere.		Watertown.		Arlington.		Milton		Winthrop.	
Population supplied,	14,445.		13,710.		11,250.		10,150.		7,740.		7,770.	
	Gallons.		Gallons.		Gallons.		Gallons.		Gallons.		Gallons.	
Month.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day	Per Capita	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	1,556,000	109	1,122,300	84	578,800	52	793,700	80	282,800	37	803,700	107
February,	1,645,500	115	1,200,300	89	584,900	53	828,700	83	301,500	40	834,100	110
March,	1,615,100	113	925,400	69	550,200	50	675,200	67	296,300	39	737,500	97
April,	1,421,900	99	807,600	60	528,500	47	648,700	65	260,800	34	673,100	88
May,	1,439,300	100	875,900	64	598,000	53	746,100	74	340,400	44	662,600	86
June,	1,527,300	106	931,200	68	693,100	62	821,100	81	373,400	48	746,800	96
July,	1,588,600	110	995,600	73	721,800	64	959,600	95	386,800	50	860,900	111
August,	1,576,300	109	999,500	72	639,000	57	796,500	78	369,200	47	878,900	112
September,	1,552,600	107	890,600	64	677,100	60	788,200	77	385,900	49	796,000	101
October,	1,448,800	99	785,200	56	629,100	55	637,200	62	282,300	36	638,300	81
November,	1,445,900	99	752,100	54	626,400	55	629,400	61	267,300	34	597,600	75
December,	1,489,100	102	922,500	66	654,800	57	706,400	68	248,100	32	677,300	85
For the year,	1,525,100	106	938,000	68	623,600	55	752,400	74	316,300	41	742,800	96

TABLE NO. 22. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	STONEHAM.		BELMONT.		LEXINGTON.		NAHANT.		SWAMPSCOTT.		METROPOLITAN DISTRICT.	
Population supplied,	6,420.		5,045.		3,620.		2,310.		6,170.		928,770.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS		GALLONS.		GALLONS.	
MONTH.	Per Day	Per Capita	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	535,300	84	226,700	46	202,600	56	108,700	80	395,900	77	133,709,700	146
February,	567,800	89	224,000	45	238,800	66	64,000	47	661,100	128	137,600,100	150
March,	541,100	85	210,100	42	250,700	70	43,900	32	352,500	68	121,032,400	132
April,	516,900	81	212,200	43	249,500	69	40,000	29	291,600	56	105,416,400	114
May,	538,300	84	250,800	50	273,200	76	88,000	37	430,900	70	107,630,100	116
June,	567,000	88	292,000	58	318,100	88	198,700	58	630,300	87	107,171,100	115
July,	583,600	91	353,500	70	341,700	95	281,600	72	789,500	102	109,917,500	118
August,	575,200	90	284,600	56	332,900	92	281,000	72	806,200	104	109,020,500	117
September,	616,900	96	291,900	57	335,200	92	249,900	74	675,200	93	109,589,100	117
October,	639,000	99	216,500	42	299,300	82	100,300	42	478,000	76	103,234,300	110
November,	502,400	78	213,600	41	266,900	73	60,800	43	374,500	70	103,367,700	110
December,	510,100	79	208,300	40	281,100	77	50,300	36	380,800	71	120,007,000	128
For the year,	558,300	87	248,800	49	282,700	78	131,000	57	521,200	84	113,922,300	123

TABLE NO. 23. — *Consumption of Water in the Metropolitan Water District, as constituted December 31, 1904, the Town of Swampscott and a Small Section of the Town of Saugus; 1893–1904.*

[Gallons per Day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	82,580,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000
May,	61,025,000	60,676,000	65,194,000	78,402,000	76,772,000	76,677,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,468,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000
Average for the year,	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000
Population,	723,153	743,354	763,557	786,385	809,213	832,042
Consumption per inhabitant,	91.5	88.0	91.0	99.7	99.8	100.5

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.
January,	96,442,000	100,055,000	111,275,000	118,435,000	125,176,000	137,771,000
February,	103,454,000	98,945,000	117,497,000	117,268,000	122,728,000	142,222,000
March,	90,200,000	97,753,000	105,509,000	108,461,000	111,977,000	123,334,000
April,	86,491,000	89,497,000	93,317,000	103,153,000	107,179,000	106,688,000
May,	89,448,000	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000
June,	97,691,000	98,581,000	103,420,000	110,002,000	105,590,000	111,209,000
July,	96,821,000	107,786,000	106,905,000	108,340,000	107,562,000	113,584,000
August,	92,072,000	102,717,000	102,815,000	107,045,000	103,570,000	112,836,000
September,	91,478,000	103,612,000	102,103,000	107,752,000	106,772,000	114,188,000
October,	89,580,000	98,358,000	103,389,000	106,560,000	103,602,000	106,290,000
November,	86,719,000	93,648,000	101,324,000	105,175,000	103,477,000	108,054,000
December,	85,840,000	97,844,000	113,268,000	125,434,000	114,721,000	125,119,000
Average for the year,	92,111,000	98,059,000	104,645,000	110,345,000	110,277,000	118,114,000
Population,	854,870	877,698	903,000	928,300	953,600	978,900
Consumption per inhabitant,	107.8	111.7	115.9	118.9	115.6	120.7

This table includes the water consumed in the cities and towns enumerated in Table No. 19, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District but have not been supplied from the Metropolitan Works.

Note relating to Chemical Examinations of Water, Tables Nos. 24–30.

The chemical examinations contained in the tables were made by the State Board of Health. Colors have been determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The more important samples are collected and examined monthly; those of less significance, at intervals of two or three months.

TABLE No. 24. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Color.		Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1904.																	
48601	Jan. 13	Slight.	Slight.	.32	34	Faintly vegetable.	Distinctly vegetable.	3.90	1.45	.0028	.0114	.0106	.0008	.30	.0120	.0001	.44	1.0
48764	Feb. 1	Slight.	V. slight.	.29	32	Faintly unpleasant.	Faintly unpleasant.	3.95	1.60	.0030	.0124	.0106	.0018	.30	.0120	.0000	.36	1.0
48942	Feb. 29	Slight.	Cons.	.33	35	Faintly unpleasant.	Faintly unpleasant.	3.20	1.20	.0020	.0132	.0112	.0020	.22	.0120	.0001	.42	0.6
49136	April 4	Decided.	Cons.	.26	30	Faintly vegetable.	Faintly vegetable.	2.80	1.00	.0022	.0104	.0088	.0016	.19	.0050	.0000	.32	0.6
49372	May 5	Slight.	Slight.	.26	30	Faintly vegetable.	Distinctly vegetable.	2.40	1.10	.0014	.0118	.0084	.0034	.22	.0040	.0001	.38	0.6
49621	June 6	V. slight.	V. slight.	.31	34	None.	Faintly unpleasant.	3.10	1.30	.0052	.0168	.0148	.0020	.19	.0020	.0001	.40	1.0
49979	July 5	Slight.	Slight, mostly sand.	.28	32	Faintly unpleasant.	Faintly unpleasant.	3.00	1.30	.0078	.0178	.0132	.0046	.19	.0030	.0003	.39	0.8
50465	Aug. 1	V. slight	Slight, also cyclops.	.21	27	V. faintly vegetable.	Faintly vegetable.	2.95	1.30	.0042	.0192	.0138	.0054	.18	.0020	.0001	.33	1.0
51211	Sept. 13	V. slight.	Cons.	.11	19	Distinctly vegetable and earthy.	Distinctly vegetable and earthy.	2.75	1.30	.0044	.0128	.0108	.0020	.22	.0020	.0000	.30	0.8
51570	Oct. 6	Slight.	Slight.	.11	19	Faintly vegetable cucumber odor.	Distinctly vegetable cucumber odor.	3.00	1.15	.0022	.0174	.0140	.0034	.23	.0010	.0001	.29	1.1
51919	Oct. 31	V. slight.	Slight.	.11	19	V. faintly vegetable.	Distinctly vegetable and unpleasant.	2.60	1.30	.0016	.0154	.0118	.0036	.23	.0010	.0001	.31	1.0
52330	Dec. 5	V. slight.	Slight.	.11	19	None.	Faintly vegetable.	3.10	1.15	.0018	.0166	.0148	.0018	.30	.0040	.0000	.34	1.4
Av.	....	....	.. ..	.22	28	....	....	3.06	1.26	.0032	.0146	.0119	.0027	.23	.0050	.0001	.36	0.9

TABLE No. 25. — *Chemical Examinations of Water from Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color. Nessler Standard.	Appearance. Color. Transformed to Platinum Standard.	Odor. Cold.	Odor. Hot.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1904.																	
48580	Jan. 11	Slight.	V. slight.	.40	39	Faintly unpleasant.	Distinctly unpleasant.	3.85	1.65	.0040	.0176	.0148	.0028	.32	.0140	.0003	.52	1.3
48758	Feb. 1	Slight.	Slight, cyclops.	.42	40	Faintly vegetable.	Distinctly vegetable.	4.20	1.70	.0056	.0158	.0136	.0022	.32	.0130	.0001	.49	1.1
48935	Feb. 29	V. slight.	V. slight.	.30	33	None.	Distinctly oily, uroglena.	4.00	1.30	.0036	.0138	.0106	.0032	.30	.0170	.0000	.39	1.6
49129	April 4	V. slight.	V. slight.	.28	32	Faintly vegetable.	Faintly unpleasant.	3.50	1.25	.0066	.0104	.0086	.0018	.26	.0100	.0001	.36	1.3
49350	May 2	V. slight.	Cons.	.23	28	Faintly vegetable.	Distinctly vegetable.	3.45	1.55	.0032	.0174	.0126	.0048	.26	.0100	.0001	.32	1.3
49600	June 6	V. slight.	Slight.	.25	29	Distinctly vegetable.	Distinctly vegetable.	3.30	1.25	.0022	.0142	.0116	.0026	.27	.0110	.0002	.30	1.1
49964	July 5	V. slight.	Cons.	.17	24	Faintly vegetable.	Distinctly vegetable.	3.05	1.25	.0296	.0190	.0156	.0034	.23	.0040	.0001	.32	1.1
50475	Aug. 2	V. slight.	Slight.	.11	19	V. faintly vegetable.	Faintly vegetable and unpleasant.	3.00	1.15	.0008	.0134	.0120	.0014	.22	.0060	.0001	.31	0.8
51076	Sept. 6	V. slight.	Slight.	.10	18	Distinctly vegetable.	Distinctly vegetable.	2.90	1.10	.0020	.0126	.0110	.0016	.23	.0050	.0000	.30	0.8
51501	Oct. 3	None.	Slight.	.10	18	Faintly unpleasant, decaying algæ.	Distinctly unpleasant, decaying algæ.	2.65	0.95	.0018	.0142	.0134	.0008	.24	.0010	.0000	.28	1.3
51930	Nov. 1	V. slight.	Slight.	.08	15	V. faintly vegetable.	Distinctly vegetable and unpleasant.	2.70	1.15	.0022	.0176	.0150	.0026	.26	.0020	.0000	.27	1.3
52327	Dec. 5	V. slight.	V. slight.	.13	20	Faintly unpleasant organisms.	Distinctly unpleasant organisms.	3.15	1.35	.0020	.0140	.0120	.0020	.25	.0020	.0001	.30	1.4
Av.	....	....	....	.21	26	....	....	3.31	1.30	.0053	.0150	.0126	.0024	.26	.0079	.0001	.35	1.2

TABLE No. 26. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Appearance: Color.		Odor.		Residue on Evaporation.		Ammonia.	Ammonia: Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1904.																	
48565	Jan. 11	None.	V. slight.	.08	15	None.	Faintly vegetable.	4.35	2.00	.0022	.0162	.0138	.0024	.34	.0010	.0002	.31	2.0
48932	Feb. 29	None.	V. slight.	.10	18	Faintly unpleasant.	Faintly unpleasant.	4.10	2.70	.0062	.0180	.0174	.0006	.35	.0030	.0001	.29	1.7
49346	May 2	V. slight.	Slight.	.11	19	Faintly vegetable.	Faintly vegetable.	3.90	1.45	.0016	.0144	.0112	.0032	.31	.0070	.0001	.26	1.7
50043	July 11	None.	V. slight.	.08	15	Faintly unpleasant.	Distinctly unpleasant, fishy.	3.75	1.50	.0016	.0164	.0126	.0038	.30	.0010	.0002	.29	1.1
51154	Sept. 12	V. slight.	V. slight.	.05	9	Faintly vegetable.	Faintly vegetable.	3.45	1.20	.0002	.0144	.0114	.0030	.29	.0050	.0000	.23	1.1
51983	Nov. 7	V. slight.	Slight.	.08	15	V. faintly vegetable.	Faintly vegetable.	3.30	1.60	.0014	.0140	.0132	.0008	.29	.0020	.0000	.27	1.3
Av.	....	....	....	.08	15	....	....	3.81	1.53	.0022	.0156	.0133	.0023	.31	.0032	.0001	.27	1.5

TABLE NO. 27. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Color.		Odor.		Residue on Evaporation.		Ammonia.	Ammonia. Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1904.																	
48574	Jan. 11	V. slight.	Slight.	.24	29	Faintly vegetable.	Distinctly vegetable.	5.05	2.15	.0054	.0276	.0242	.0034	.52	.0050	.0007	.43	2.3
48757	Feb. 1	None.	V. slight, cyclops.	.22	27	Faintly vegetable.	Distinctly vegetable	4.75	2.00	.0022	.0168	.0150	.0018	.50	.0090	.0002	.38	2.2
48937	Feb. 29	V. slight.	V. slight.	.24	29	Faintly unpleasant.	Faintly unpleasant.	5.50	2.10	.0012	.0222	.0212	.0010	.51	.0110	.0002	.46	2.2
49127	April 4	Decided.	Slight.	.26	30	Faintly vegetable.	Faintly vegetable.	4.90	1.80	.0026	.0164	.0158	.0006	.48	.0100	.0001	.44	2.1
49359	May 2	V. slight.	Cons.	.30	33	Distinctly vegetable.	Distinctly vegetable.	4.70	1.90	.0036	.0172	.0148	.0024	.51	.0110	.0001	.51	2.1
49603	June 6	V. slight.	Slight.	.27	31	Faintly vegetable.	Distinctly vegetable.	4.65	1.85	.0018	.0190	.0144	.0046	.49	.0100	.0002	.42	2.3
49960	July 5	V. slight.	Slight.	.20	26	Faintly unpleasant.	Faintly unpleasant.	4.60	1.70	.0026	.0216	.0174	.0042	.47	.0060	.0002	.56	1.8
50470	Aug. 1	None.	Slight.	.16	23	None.	V. faintly vegetable.	4.75	1.70	.0028	.0184	.0170	.0014	.47	.0050	.0001	.43	2.0
51071	Sept. 6	V. slight.	Cons.	.10	18	None.	Faintly vegetable.	4.95	1.95	.0008	.0220	.0168	.0052	.50	.0050	.0000	.41	1.7
51506	Oct. 3	V. slight.	Cons.	.13	20	None.	Faintly vegetable.	4.50	1.55	.0016	.0210	.0156	.0054	.49	.0020	.0001	.38	2.1
51913	Oct. 31	Slight.	Slight.	.17	24	V. faintly vegetable.	Distinctly vegetable.	4.90	1.90	.0018	.0190	.0160	.0030	.52	.0100	.0001	.41	2.0
52321	Dec. 5	V slight.	Slight.	.24	29	Faintly unpleasant.	Distinctly cucumber.	4.95	2.05	.0032	.0164	.0142	.0022	.49	.0040	.0001	.37	2.1
Av.	....	....	....	.21	27	....	....	4.85	1.89	.0025	.0198	.0169	.0029	.50	.0078	.0002	.43	2.1

TABLE NO. 28. — *Chemical Examinations of Water from a Faucet at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Color.		Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1904.																	
48568	Jan. 11	V. slight.	V. slight.	.26	30	None.	Faintly vegetable.	4.50	1.80	.0038	.0150	.0138	.0012	.39	.0080	.0004	.39	2.0
48748	Feb. 1	V. slight.	V. slight.	.28	32	Faintly vegetable.	Distinctly vegetable.	4.65	1.75	.0034	.0114	.0108	.0006	.40	.0120	.0000	.37	1.7
48926	Feb. 29	Slightly milky.	Slight.	.32	34	None.	None.	4.40	1.75	.0028	.0134	.0114	.0020	.38	.0160	.0001	.39	1.7
49122	Apr. 4	V. slight.	Slight.	.24	29	Faintly vegetable.	Faintly vegetable.	3.65	1.65	.0026	.0098	.0092	.0006	.33	.0160	.0002	.37	1.6
49343	May 2	V. slight.	Slight.	.22	27	Faintly vegetable.	Distinctly vegetable.	3.50	1.30	.0020	.0104	.0088	.0016	.26	.0200	.0001	.43	1.4
49593	June 6	V. slight.	Cons.	.25	29	V. faintly vegetable.	Faintly vegetable.	3.35	1.25	.0014	.0108	.0102	.0006	.27	.0170	.0000	.30	1.3
49952	July 5	V. slight.	Cons.	.20	26	Faintly vegetable.	Distinctly vegetable.	3.50	1.45	.0010	.0144	.0118	.0026	.26	.0110	.0000	.28	1.0
50463	Aug. 2	None.	Slight.	.12	20	Faintly vegetable.	Faintly vegetable.	3.65	1.65	.0036	.0154	.0136	.0018	.28	.0110	.0000	.32	1.1
51066	Sept. 6	V. slight.	Slight.	.25	29	Faintly vegetable.	Distinctly vegetable and cucumber.	4.00	1.70	.0012	.0160	.0148	.0012	.35	.0060	.0001	.43	1.4
51512	Oct. 4	V. slight.	Slight.	.11	19	Faintly vegetable.	Faintly vegetable.	4.10	1.55	.0014	.0182	.0148	.0034	.42	.0060	.0001	.36	1.8
51907	Oct. 31	V. slight.	V. slight.	.22	27	V. faintly unpleasant.	Faintly unpleasant and fishy.	3.90	1.60	.0014	.0160	.0140	.0020	.39	.0050	.0000	.38	1.7
52317	Dec. 5	V. slight.	V. slight.	.31	34	None.	Faintly unpleasant.	3.95	1.60	.0026	.0160	.0126	.0034	.40	.0040	.0001	.47	1.6
Av.	....	....	....	.23	28	....	....	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5

TABLE NO. 29. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works. — 1904.*

[Parts per 100,000.]

LOCALITY.	Samples Collected.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
		Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID. Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Quinepoxet River, Holden,	Bi-monthly,	.49	46	3.94	1.64	.0078	.0281	.0211	.0070	.33	.0043	.0001	.64	0.7
Stillwater River, Sterling,	Bi-monthly,	.37	37	3.37	1.41	.0062	.0200	.0172	.0028	.23	.0032	.0001	.51	1.0
Wachusett Reservoir, Clinton,	Monthly,	.22	28	3.06	1.26	.0032	.0146	.0119	.0027	.23	.0050	.0001	.36	0.9
Marlborough (Walker's) Brook,	Monthly,	.44	42	15.91	4.43	.2204	.0461	.0282	.0179	2.51	.1189	.0055	.56	5.8
Marlborough Brook filter-beds, effluent,	Monthly,	.14	21	1.39	-	.1051	.0159	-	-	1.97	.1895	.0006	.30	5.1
Sudbury Reservoir, surface,	Monthly,	.21	27	3.31	1.30	.0053	.0150	.0126	.0024	.26	.0079	.0001	.35	1.2
Framingham Reservoir No. 3, near dam,	Quarterly,	.20	26	3.49	1.31	.0021	.0147	.0123	.0024	.27	.0225	.0001	.33	1.3
Hopkinton Reservoir, surface,	Quarterly,	.46	43	3.71	1.74	.0040	.0213	.0183	.0030	.33	.0045	.0001	.60	0.8
Ashland Reservoir, surface,	Quarterly,	.52	48	3.60	1.75	.0026	.0188	.0165	.0023	.27	.0030	.0000	.65	0.9
Framingham Reservoir No. 2, near dam,	Quarterly,	.55	50	3.86	1.81	.0031	.0213	.0184	.0029	.30	.0067	.0001	.67	1.0
Lake Cochituate,	Monthly,	.21	27	4.85	1.89	.0025	.0198	.0169	.0029	.50	.0073	.0002	.43	2.1
Terminal chamber, Sudbury Aqueduct,	Bi-monthly,	.27	32	3.82	1.49	.0029	.0139	.0121	.0018	.30	.0100	.0001	.42	1.4
Spot Pond,	Bi-monthly,	.08	15	3.81	1.53	.0022	.0156	.0133	.0023	.31	.0032	.0001	.27	1.5
Tap in Revere,	Bi-monthly,	.07	13	3.57	1.25	.0016	.0131	.0113	.0018	.31	.0040	.0001	.25	1.6
Tap at State House,	Monthly,	.23	28	3.98	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
Tap in Quincy,	Bi-monthly,	.20	26	3.91	1.54	.0011	.0128	.0115	.0013	.34	.0146	.0001	.37	1.7

TABLE No. 30. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1904.*

[Parts per 100,000.]

Year.	Color.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
						Total.	Dis-solved.	Sus-pended.					
1892, . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
1893, . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0187	.0001	.35	1.1
1900, . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . .	.25	29	3.96	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . .	.23	28	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5

TABLE No. 31. — *Colors of Water from Various Parts of the Metropolitan Water Works, 1904. (Means of Weekly Determinations.)*

[Platinum Standard.]

Month.	Wachusett Reservoir.	Sudbury Reservoir.				Framingham Reservoir No. 3.	Spot Pond.	Fells Reservoir.
	Surface.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Mid-depth.	Mid-depth.	Effluent Gate-house.
January, ...	48	52	47	44	48	41	25	23
February, . . .	38	44	44	44	38	40	23	20
March, ...	39	35	37	37	59	37	24	20
April, ...	39	36	36	36	44	33	22	20
May, ...	39	34	36	35	45	33	20	20
June, ...	40	33	33	33	40	34	20	19
July, ...	39	27	27	29	38	28	20	19
August, ...	30	24	24	25	32	24	19	18
September, . . .	25	22	23	23	27	24	21	18
October, ...	23	21	22	22	25	25	21	18
November, . . .	21	17	17	17	31	20	19	18
December, . . .	23	19	17	17	24	18	20	18
Mean, . . .	34	30	30	30	38	30	21	19

TABLE No. 31 — *Concluded.*

[Platinum Standard.]

Month.	Lake Cochituate.				Chestnut Hill Reservoir.			Northern Service.		Southern Service.	
	Surface.	Mid-depth.	Bottom.	Influent Streams.*	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Tap at Glenwood Yard, Medford (Low Service).	Tap at 44 Clarendon Street, Malden (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	34	34	36	56	42	35	41	-	-	43	41
February,	26	29	30	72	41	29	37	-	-	39	38
March,	33	31	33	77	37	32	35	-	-	36	34
April,	38	37	41	78	34	31	38	32	20	33	32
May,	36	34	34	91	35	-	33	31	20	34	33
June,	33	32	40	82	35	-	34	34	20	34	34
July,	31	33	55	62	30	30	28	29	19	30	30
August,	27	31	74	47	25	25	24	23	17	25	25
September,	27	32	93	48	38	27	32	32	18	29	32
October,	27	29	104	62	36	29	30	28	19	26	29
November,	33	33	48	57	45	32	39	34	24	29	37
December,	32	29	30	63	34	28	32	32	18	27	31
Mean,	31	32	52	66	36	-	33	-	-	32	33

* The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE No. 32. — *Temperatures of Water from Various Parts of the Metropolitan Water Works, 1904. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

Month.	Wachusett Reservoir.	Sudbury Reservoir (Depth at Place of Observation 54.5 Feet).				Framingham Reservoir No. 3 (Depth at Place of Observation 20.5 Feet).			Lake Cochituate (Depth at Place of Observation 62.0 Feet).		
	Surface.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January,	32.4	32.3	33.0	34.3	33.2	34.1	35.0	35.8	34.6	35.6	36.0
February,	33.8	31.9	32.8	34.4	32.0	33.9	35.0	36.0	34.9	36.0	37.1
March,	33.1	32.8	33.3	33.8	35.0	35.6	36.3	36.7	36.0	36.8	37.8
April,	40.6	44.3	43.7	42.7	37.8	45.5	45.3	45.3	43.3	42.5	41.6
May,	55.4	59.3	56.4	54.6	55.0	61.3	59.8	57.5	59.7	46.9	45.4
June,	66.4	68.9	65.3	63.5	63.8	70.3	68.7	67.1	67.4	47.8	45.8
July,	67.3	75.3	72.5	69.8	70.0	75.5	73.5	70.8	71.8	49.0	45.3
August,	71.0	73.5	72.9	72.3	71.5	73.3	72.7	71.8	71.2	49.3	46.8
September,	68.2	66.7	66.0	65.7	66.3	67.3	66.5	66.4	65.3	50.5	47.0
October,	56.7	57.5	56.1	55.6	55.5	55.0	55.0	40.0	55.8	51.5	46.8
November,	44.1	41.5	42.3	42.4	40.2	40.6	41.4	40.0	44.8	43.1	42.2
December,	35.0	33.5	36.0	37.4	34.8	34.3	35.3	35.8	32.5	34.0	36.3
Mean,	50.3	51.5	50.9	50.5	49.6	52.2	52.0	50.3	51.4	43.6	42.3

Table No. 32 — *Concluded.*

[Degrees Fahrenheit.]

Month.	Chestnut Hill Reservoir.	Spot Pond (Depth at Place of Observation 28.0 Feet).			Northern Service.		Southern Service.	
	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at 44 Clarendon Street, Malden (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	35.5	33.5	34.0	34.5	-	-	37.9	37.5
February,	36.1	34.1	35.9	36.0	-	-	38.1	37.2
March,	36.5	35.8	36.5	37.4	-	-	38.3	37.9
April,	44.8	42.8	42.7	42.8	42.5	42.3	46.6	45.8
May,	59.6	58.1	57.4	53.3	55.0	51.4	57.7	58.0
June,	67.6	67.8	66.9	59.3	61.6	58.5	67.0	67.3
July,	73.1	73.7	72.7	63.1	68.3	64.8	71.2	71.4
August,	73.9	72.6	72.2	66.8	69.1	66.6	73.0	72.8
September,	67.8	66.3	65.7	66.7	65.6	64.1	68.0	68.0
October,	56.4	56.7	56.3	56.3	58.5	59.0	57.7	57.2
November,	43.1	39.5	39.5	39.6	47.2	50.3	46.0	45.8
December,	36.2	34.8	35.4	35.4	39.1	41.4	38.8	38.7
Mean,	52.6	51.3	51.3	49.3	-	-	53.4	53.1

Table No. 33. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works, 1904.*

[Degrees Fahrenheit.]

Month.	Chestnut Hill Reservoir.			Framingham.			Clinton.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	43.0	−17.0	20.5	45	−24	18.3	37.5	−16.0	14.9
February,	47.5	−8.0	21.1	48	−5	20.2	47.0	−7.0	17.6
March,	71.0	2.0	34.4	68	0	34.3	67.0	−4.0	31.2
April,	70.0	22.0	45.3	73	20	45.2	70.0	21.0	43.2
May,	89.0	34.0	61.7	89	34	60.8	85.0	38.0	60.9
June,	94.5	39.0	63.8	92	39	64.1	90.5	35.5	63.3
July,	93.5	47.0	71.5	93	48	70.8	90.0	49.0	69.9
August,	91.5	44.0	68.4	90	44	67.1	86.5	46.0	66.9
September,	88.0	29.5	62.4	85	25	61.1	81.0	27.0	59.6
October,	75.0	25.0	49.4	75	20	48.3	74.5	22.0	47.7
November,	58.0	10.0	36.2	58	6	35.1	54.0	10.0	33.4
December,	46.5	2.0	23.6	48	−7	22.7	49.5	−4.5	20.9
Average,	-	-	46.5	-	-	45.7	-	-	44.1

TABLE No. 34. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same.*

	Diameter of Pipes in Inches.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated January 1, 1904 (feet),	9,069	171,100	8,075	46,626	26,922	46,651	57,088	54,394	26	21,568	644	1,585	798	444,546
Gate valves in same,	-	42	-	39	28	36	38	62	1	67	15	12	13	353
Air valves in same,	5	102	3	35	4	19	34	29	-	9	-	-	-	240
Length laid or relaid during 1904 (feet),	-	174	-	-	-	80	-	7	-	638	51	12	60	1,022
Gate valves in same,	-	-	-	-	-	1	-	-	-	2	2	-	3	8
Air valves in same,	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Length abandoned during 1904 (feet),	-	174	-	-	-	80	-	7	-	597	81	-	-	939
Gate valves in same,	-	-	-	-	-	-	-	-	-	-	4	-	1	5
Air valves in same,	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Length owned and operated January 1, 1905 (feet),	9,069	171,100	8,075	46,626	26,922	46,651	57,088	54,394	26	21,609	614	1,597	858	444,629*
Gate valves in same,	-	42	-	39	28	37	38	62	1	69	13	12	15	356
Air valves in same,	5	102	3	35	4	19	34	29	-	9	-	-	-	240

* 84.21 miles.

TABLE No. 35. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes laid to January 1, 1905, owned and operated by Metropolitan Water and Sewerage Board.*

	Diameter of Pipes in Inches.								Total.
	24	20	16	12	10	8	6	4	
Length laid to January 1, 1904 (feet),	352	298	2,214	4,418	173	315	2,649	1,150	11,564
Length laid during 1904 (feet),	-	-	36	-	-	-	-	8	44
Length abandoned during 1904 (feet),	-	-	-	-	-	-	-	14	14
Total length in use January 1, 1905 (feet),	352	298	2,250	4,418	173	315	2,649	1,144	11,594
Valves set to January 1, 1904,	-	-	18	75	1	1	54	39	188
Valves set during 1904,	-	-	-	-	-	-	-	-	-
Valves abandoned during 1904,	-	-	-	-	-	-	-	1	1
Total valves in use January 1, 1905,	-	-	18	75	1	1	54	38	187

TABLE NO. 36. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works.*

BY WHOM OWNED.	INCHES.																			TOTAL.	
	60	48	42	40	36	30	28	24	20	18	16	14	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works.	9,069	171,100	8,075	-	46,626	26,922	-	46,651	57,088	-	54,394	26	21,609	614	1,597	-	858	-	-	444,629	84.21
Boston, . . .	-	38,494	16,813	23,104	43,113	88,379	244	80,198	93,695	-	193,492	-	1,165,647	181,289	585,190	-	1,833,270	-	87,039	3,874,967	733.90
Somerville, . .	-	-	-	-	-	-	-	-	3,596	387	2,071	8,087	78,984	46,818	90,271	-	194,033	-	20,525	444,722	84.23
Malden, . . .	-	-	-	-	-	-	-	-	-	-	-	9,152	65,397	23,579	69,840	-	195,091	-	69,196	432,225	81.87
Chelsea, . . .	-	-	-	-	-	-	-	-	-	-	2,380	-	-	39,501	25,570	-	126,935	-	9,617	204,003	38.64
Quincy, . . .	-	-	-	-	-	-	-	-	2,679	-	20,040	-	28,511	32,166	86,505	994	210,214	948	97,719	474,776	89.92
Everett, . . .	-	-	-	-	-	-	-	2,484	2,900	-	2,233	206	5,570	37,406	18,275	-	128,221	-	30,790	228,085	43.20
Medford, . .	-	-	-	-	-	-	-	-	673	-	6,775	9,784	24,658	30,119	65,951	-	87,895	-	47,164	273,019	51.71
Melrose, . . .	-	-	-	-	-	-	-	-	-	-	5,178	2,920	23,075	10,545	23,464	-	105,386	-	70,672	241,240	45.69
Revere,* . . .	-	-	-	-	-	-	-	-	-	-	22,650	5,700	7,380	8,550	16,511	-	65,282	-	69,492	195,565	37.04
Watertown, . .	-	-	-	-	-	-	-	-	-	-	400	12,127	5,959	4,169	19,261	-	108,872	-	13,239	164,027	31.06
Winthrop,* . .	-	-	-	-	-	-	-	-	-	-	-	-	4,000	4,800	20,447	-	26,264	-	71,928	127,439	24.14
Belmont, . .	-	-	-	-	-	-	-	-	-	-	-	-	2,161	12,302	13,696	-	73,371	-	283	101,813	19.28
Nahant, . . .	-	-	-	-	-	-	-	-	-	-	-	-	150	11,550	4,850	-	32,740	-	35,100	84,390	15.98
Arlington, . .	-	-	-	-	-	-	-	-	-	-	-	-	31,804	20,036	21,359	-	82,598	-	30,564	186,361	35.29
Swampscott, . .	-	-	-	-	-	-	-	-	-	-	-	-	12,072	13,634	13,217	-	47,294	-	9,110	95,327	18.05
Stoneham, . .	-	-	-	-	-	-	-	-	-	-	-	-	4,525	4,725	2,975	-	85,092	-	12,829	110,146	20.86
Milton, . . .	-	-	-	-	-	-	-	-	-	-	103	44	22,331	16,630	31,807	-	101,923	-	12,497	185,835	35.10
Lexington, . .	-	-	-	-	-	-	-	-	-	-	-	-	9,000	2,264	6,860	-	42,087	-	32,960	93,121	17.64
Total feet, .	9,069	204,594	24,888	23,104	89,739	115,301	244	129,333	160,631	387	309,716	47,996	1,507,833	450,697	1,117,646	994	3,047,376	948	720,724	7,961,220	-
Total miles, .	1.72	38.75	4.71	4.38	17.00	21.84	.05	24.49	30.42	.07	58.66	9.09	285.57	85.36	211.68	.19	577.15	.18	136.50	-	1,507.81

* Pipes owned by Revere Water Company.

Table No. 37. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works.*

City or Town.	Services.	Meters.	Fire Hydrants.
Boston,	90,571	4,748	7,919
Somerville,	11,055	1,275	986
Malden,	6,750	4,759	404
Chelsea,	6,357	126	296
Quincy,	5,378	184	661
Everett,	4,853	78	504
Medford,	4,142	218	489
Melrose,	3,307	105	284
Revere,	2,623	60	127
Watertown,	1,767	1,666	322
Winthrop,	1,891	25	117
Belmont,	651	651	153
Nahant,	425	71	65
Arlington,	1,806	115	357
Swampscott,	1,171	-	125
Stoneham,	1,327	26	103
Milton,	1,127	1,127	283
Lexington,	660	12	94
Total,	145,861	15,246	13,289

TABLE No. 38. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose, at Different Stations on the Metropolitan Water Works.*

1904. MONTH.	LOW-SERVICE.														SOUTHERN HIGH-SERVICE.			
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD WATER WORKS OFFICE, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA WATER WORKS OFFICE, PARK STREET.		BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	123	114	186	181	166	164	167	165	166	163	163	160	152	144	247	238	261	259
February, .	123	115	187	184	166	165	166	165	168	165	161	158	147	138	246	238	263	260
March, .	133	121	189	182	166	164	167	165	168	164	162	159	155	147	248	239	263	260
April, . .	139	128	184	174	166	163	166	165	166	162	163	160	161	153	248	239	263	260
May, . .	150	125	181	174	166	163	166	163	167	162	163	159	162	151	248	237	262	259
June, . .	152	128	186	176	167	164	166	164	168	165	163	160	163	153	247	236	262	257
July, . .	153	127	186	178	167	164	166	164	168	164	163	160	163	152	246	237	263	257
August, .	147	126	183	174	167	164	166	164	168	164	163	160	163	154	246	237	261	257
September, .	139	126	186	177	167	164	167	164	169	165	163	160	163	154	247	236	262	258
October, .	134	128	180	174	165	162	166	164	167	163	163	160	162	153	247	238	261	258
November, .	134	127	187	177	167	164	167	165	170	166	164	163	162	156	248	238	260	258
December, .	127	120	180	173	167	164	167	165	170	166	165	162	157	151	246	237	262	259
Averages,	138	124	185	177	166	164	166	164	168	164	163	160	159	151	247	238	262	259

TABLE NO. 38. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.* — Concluded.

1904. MONTH.	SOUTHERN HIGH-SERVICE — Concluded.						NORTHERN HIGH-SERVICE.								NORTHERN EXTRA HIGH-SERVICE.	
	BELMONT TOWN HALL, PLEASANT STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STATION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January,	258	252	248	243	235	223	268	258	266	264	256	250	254	245	390	376
February,	260	253	247	243	232	219	265	255	269	266	253	244	252	241	390	374
March,	258	253	249	244	235	220	268	259	269	267	260	254	259	251	390	373
April,	260	253	249	244	238	224	268	260	269	267	263	254	261	251	384	372
May,	262	252	248	241	239	222	268	256	269	266	261	250	258	245	387	372
June,	262	250	247	240	238	214	266	255	268	264	262	243	257	230	388	370
July,	262	254	247	239	236	211	267	257	268	264	259	235	253	223	385	369
August,	259	254	246	242	238	213	268	259	267	263	260	234	256	222	386	369
September,	259	253	247	243	236	215	268	258	268	264	261	238	258	230	386	368
October,	259	254	248	246	237	219	268	265	270	267	264	252	263	249	388	371
November,	259	255	247	242	238	222	270	261	270	267	266	256	265	255	386	376
December,	260	256	247	241	237	222	270	260	270	267	264	254	262	254	381	370
Averages,	260	253	248	242	237	219	268	259	269	266	261	247	258	241	387	372

Appendix No. 4.

Water Works Statistics for the Year 1904.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

City or Town.	Population, Census of 1900.	Estimated Population, May 1, 1904.
Boston,	560,892	610,300
Somerville,	61,643	70,000
Chelsea,	34,072	37,800
Malden,	33,664	40,700
Newton,*	33,587	39,000
Everett,	24,336	29,200
Quincy,	23,899	27,700
Medford,	18,244	22,000
Hyde Park,*	13,244	14,500
Melrose,	12,962	14,400
Revere,	10,395	13,400
Watertown,	9,706	11,200
Arlington,	8,603	10,100
Milton,	6,578	7,700
Stoneham,	6,197	6,400
Winthrop,	6,058	7,700
Belmont,	3,929	5,000
Lexington,	3,831	4,100
Nahant,	1,152	1,400
Total population of Metropolitan Water District,	872,992	972,600
Swampscott,†	4,548	5,200
Saugus,‡	158	200

* No water supplied to these places during the year from Metropolitan Water Works.

† Not in the Metropolitan Water District, but has been supplied with water from the Metropolitan Water Works.

‡ Only a small portion of Saugus is supplied with water.

Sources of Supply.

Source.	Area of Watershed (Square Miles).	Remarks.
Lake Cochituate, ...	18.87	Works built by city of Boston in 1848.
Sudbury River, ...	75.20	Works built by city of Boston in 1872–78.
Nashua River (South Branch), ...	118.81	Works begun in 1895; not finished.

Mode of Supply.

26 per cent. from gravity.

74 per cent. from pumping.

Pumping.

Chestnut Hill High-service Station: —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Quemahoning, Georges Creek Cumberland, Pocahontas and Cumberland steam; anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $4.15 to $5.36, buckwheat $3.28, screenings $2.24 and $3.44. Average price per gross ton $3.87. Per cent. ashes, 12.4.

Chestnut Hill Low-service Station: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Quemahoning, Georges Creek Cumberland, Pocahontas and Cumberland steam; anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $3.98 to $5.36, buckwheat $3.08, screenings $2.24 to $3.67. Average price per gross ton $3.97. Per cent. ashes, 12.0.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Georges Creek Cumberland; anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $4.40, buckwheat $3.75, screenings $2.24. Average price per gross ton $3.65. Per cent. ashes, 13 9.

	Chestnut Hill High-service Station.		
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.
Daily pumping capacity (gallons), ...	16,000,000	20,000,000	30,000,000
Coal consumed for year (pounds), ...	1,012,902	279,676	8,656,737
Cost of pumping, figured on pumping station expenses, . .	$4,181.34	$1,326.52	$29,567.41
Total pumpage for year, corrected for slip (million gallons), .	576.20	292.86	10,522.75
Average dynamic head (feet), ...	120.69	127.90	129.30
Gallons pumped per pound of coal, ...	568.12	1,047.14	1,215.56
Duty on basis of plunger displacement, ...	65,400,000	120,540,000	134,960,000
Cost per million gallons raised to reservoir, ...	$7.170	$4.529	$2.810
Cost per million gallons raised one foot, ...	0.059	0.035	0.022

	Chestnut Hill Low-service Station.	Spot Pond Station.
	Engines Nos. 5, 6 and 7.	Engine No. 9.
Daily pumping capacity (gallons),	105,000,000	20,000,000
Coal consumed for year (pounds),	8,662,868	2,462,802
Cost of pumping, figured on pumping station expenses,	$33,864.15	$11,868.79
Total pumpage for year, corrected for slip (million gallons),	20,268.94	2,927.47
Average dynamic head (feet),	54.91	129.33
Gallons pumped per pound of coal,	2,339.75	1,188.67
Duty on basis of plunger displacement,	110,290,000	132,070,000
Cost per million gallons raised to reservoir,	$1.671	$4.054
Cost per million gallons raised one foot,	0.030	0.031

Consumption.

Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1904,	927,800
Total consumption, gallons,	42,057,180,000
Average daily consumption, gallons,	114,909,000
Gallons per day to each inhabitant,	123.9

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	-*	-†
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions less length abandoned, miles,	.02	13.71
Length in use, miles,	84.21	1,507.81
Stop gates added,	3	-
Stop gates now in use,	356	-
Service pipes added,	-	1,343
Service pipes now in use,	-	145,861
Meters added,	-	882
Meters now in use,	-	15,246
Fire hydrants added,	-	178
Fire hydrants now in use,	-	13,289

* Cast-iron and cement-lined wrought iron. † Cast-iron, cement-lined wrought iron and kalamine.

Appendix No. 5.

Contracts made and pending during

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	44	Section 63, Belmont Extension, Cambridge, 22 in by 28 in., 24 in. by 28 in. and 25 in. diameter brick sewer in open cut and tunnel.	7	$49,691 50	$45,288 00	Gow & Palmer, Boston, Mass.
2	45	Pile driving, in advance of excavation, on Sections 61 and 62, Revere Extension, Chelsea.	-	-	-	Mayo Contracting Co., Boston, Mass.
3	46	Part of Section 62, Revere Extension, Chelsea, 48 in. brick sewer in tunnel.	-	-	-	Chas. A. Haskin, Boston, Mass.
4	50	Part of Section 61, Revere Extension, Chelsea, 608 linear feet of 54 in. brick sewer in tunnel.	-	-	-	Chas. A. Haskin, Boston, Mass.
		Total, ...	. .	. . .	. . .	. . . . . .

Contracts relating to the

5	16	Section 77, High-level Sewer, Roxbury, pumping plant for Ward Street pumping station.	3	$207,000 00	$204,000 00	Allis-Chalmers Co., Milwaukee, Wis.
6	22	Part of Section 43, Quincy and Hull, westerly line of 60-inch cast-iron pipe, harbor outfalls.	2	109,273 50	94,492 45	Hiram W. Phillips, Quincy, Mass.
7	27	Section 77, High-level Sewer, Roxbury, Ward Street pumping station and connections.	6	235,719 50	224,505 00	L. P. Soule & Son, Boston, Mass.
8	35	Parts of Section 44, High-level Sewer, Quincy.	4	133,845 00	125,554 60	W. H. Ellis, Boston, Mass.
9	33	Section 46, High-level Sewer, Quincy.	3	40,328 00	37,044 00	W. H. Ellis, Boston, Mass.
10	36	Section 76, High-level Sewer, Roxbury, laying 48-inch force-mains and building connecting sewer.	4	29,150 00	26,230 00	H. P. Nawn, Boston, Mass.

Appendix No. 5.

THE YEAR 1904 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1904.	10. Value of Work done Dec. 31, 1904.	
Sept. 14, '03,	Apr. 23, '04,	- -	$47,273 69	1
Oct. 9, '03,	June 24, '04,	- -	13,802 80	2
Oct. 23, '03,	Apr. 14, '04,	- -	27,902 68	3
May 3, '04,	Aug. 18, '04,	For completed sewer in tunnel, except piling to be furnished and placed by the Board, $21 per linear foot.	12,768 00	4
. . .	. . .	. . . .	$101,747 17	

South Metropolitan System.

Jan. 17, '02,	-	- -	$153,000 00	5
May 28, '02,	Sept. 29, '04,	- -	94,592 96	6
Oct. 8, '02,	May 31, '04,	- -	227,140 93	7
June 11, '03,	May 26, '04,	- -	114,850 23	8
June 11, '03,	May 14, '04,	- -	29,453 38	9
June 9, '03,	Jan. 23, '04,	- -	29,366 06	10

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	43	Part of Section 43, High-level Sewer, Quincy and Hull, easterly line of 60-inch cast-iron pipe, harbor outfalls.	-	-	-	Hiram W. Phillips, Quincy, Mass.
2	42	Two vertical fire-tube boilers and fittings for the Nut Island screen-house, Quincy.	5	$6,430 00	$6,315 00	Edward Kendall & Sons, Cambridge, Mass.
3	39	Part of Section 44, High-level Sewer, Quincy, screen-house on Nut Island.	6	29,971 00	29,940 00	Woodbury & Leighton Co., Boston, Mass.
4	40	Quincy pumping station, force-main line, 299 tons 24-inch cast-iron pipe and special castings.	3	7,857 60	7,238 50	Camden Iron Works, Camden, N. J.
5	47	Easterly line of Section 43, High-level Sewer, Quincy and Hull, 2,265 tons 60-inch cast-iron pipe and special castings.	2	64,617 80	56,966 70	Camden Iron Works, Camden, N. J.
6	49	Screening machinery for the Nut Island screen-house, and the Ward Street pumping station of the High-level Sewer, Quincy and Roxbury.	2	31,100 00	24,054 00	The Lockwood Manufacturing Company, Boston.
7	48	Additional filling on embankments and completing Rock Island Road over Section 48, High-level Sewer, Quincy.	4	9,570 00	7,500 00	Joseph J. Moebs, Boston, Mass.
		Total, ...	. .	. . .	. . .	. . . .

THE YEAR 1904 — SEWERAGE WORKS — *Continued.*

South Metropolitan System — Concluded.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1904.	10. Value of Work done Dec. 31, 1904.	
June 30, '03,	Nov. 2, '04,	- -	$99,511 04	1
Aug. 14, '03,	Nov. 1, '04,	- -	6,315 00	2
Sept. 11, '03,	Oct. 20, '04,	- -	29,940 00	3
Dec. 21, '03,	May 31, '04,	- -	7,291 67	4
Dec. 21, '03,	Aug. 27, '04,	- -	56,091 28	5
May 19, '04,	Nov. 3, '04,	Nut Island screening machinery, $12,862; Ward Street screening machinery, $11,192.	24,054 00	6
May 23, '04,	Oct. 21, '04,	Earth excavation and filling on embankments, $0.54 per cu. yd., loam and peat excavation and placing on slopes of embankments, $0.65 per cu. yd., placing rock ballast, $1 per cu. yd. in place.	7,113 55	7
. . .	. . .	. . . .	$878,720 10	

Contracts made and pending during the Year 1904 — Sewerage Works — *Concluded.*

Summary of Contracts.*

	Value of Work done December 31, 1904.
North Metropolitan System, 4 contracts,	$101,747 17
South Metropolitan System, 13 contracts,	878,720 10
Total of 17 contracts made and pending during the year 1904,	$980,467 27

* In this summary the cost of day work, and contracts charged to maintenance are excluded.

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1904 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1904.

[CHAPTER 30.]

AN ACT MAKING AN APPROPRIATION FOR PRINTING AND BINDING THE ANNUAL REPORT OF THE METROPOLITAN WATER AND SEWERAGE BOARD.

Be it enacted, etc., as follows:

Report of the metropolitan water and sewerage board.

SECTION 1. The sum of twenty-five hundred dollars is hereby appropriated, to be paid out of the treasury of the Commonwealth from the ordinary revenue, for printing and binding the annual report of the metropolitan water and sewerage board, the cost of the same to be assessed and collected by the treasurer and receiver general equally upon and from the metropolitan water and metropolitan sewerage districts.

SECTION 2. This act shall take effect upon its passage. [*Approved January 30, 1904.*

[CHAPTER 60.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

South metropolitan system of sewage disposal.

SECTION 1. A sum not exceeding one hundred and thirty-five thousand dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton, Quincy and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the year ending on the thirty-first day of December, nineteen hundred and four.

SECTION 2. This act shall take effect upon its passage. [*Approved February 6, 1904.*

[CHAPTER 62.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

North metropolitan system of sewage disposal.

SECTION 1. A sum not exceeding one hundred and twenty-three thousand dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, to provide for the cost of maintaining and operating the system of sewage disposal for the cities of Boston, Cambridge, Somerville, Malden, Chelsea, Woburn, Medford, Melrose and Everett, and the towns of Stoneham, Winchester, Arlington and Belmont, known as the North Metropolitan System, during the year ending on the thirty-first day of December, nineteen hundred and four.

SECTION 2. This act shall take effect upon its passage. [*Approved February 6, 1904.*

[CHAPTER 186.]

AN ACT TO EXTEND THE TIME FOR FILING PETITIONS FOR DAMAGES AND OFFERS OF SURRENDER OF REAL ESTATE UNDER THE ACT TO PROVIDE FOR A METROPOLITAN WATER SUPPLY.

Be it enacted, etc., as follows:

1893, 342, § 1, etc., amended.

SECTION 1. Section one of chapter three hundred and forty-two of the acts of the year eighteen hundred and ninety-nine, as amended by section one of chapter one hundred and eight of the acts of the year nineteen hundred, and by section one of chapter four hundred and ninety-eight of the acts of the year nineteen hundred and one, is hereby further amended by striking out the word "four", in the seventeenth line, and inserting in place thereof the word: — five, — so as to read as follows: —

Time within which certain petitions for damages, etc., may be filed extended.

Section 1. Petitions under the provisions of section fourteen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, or of section one of chapter four hundred and forty-five of the acts of the year eighteen hundred and ninety-seven, and acts in amendment thereof or in addition thereto, for the determination of damages for the taking of real estate may be filed, as provided by law, within two years after the actual taking by right of eminent domain of such real estate or of any interest therein, and petitions for the determination of damages for the taking of water rights where no land is taken in connection with such water rights, and for the determination of all other damage provided for in said acts,

and offers of surrender of real estate provided for in said acts, may be filed on or before the first day of July in the year nineteen hundred and five.

SECTION 2. This act shall take effect upon its passage. [*Approved March 29, 1904.*

[CHAPTER 230.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO DETERMINE THE LINES AND GRADES OF THE HIGH LEVEL METROPOLITAN SEWER ABOVE THE POINT WHERE THE SEWAGE OF THE CHARLES RIVER VALLEY IS TO BE RECEIVED.

Be it enacted, etc., as follows:

SECTION 1. The metropolitan water and sewerage board is hereby authorized to determine the location, elevation and size of the high level metropolitan sewer above the point where the sewage from the Charles River valley is to be received. Location, etc., of high level metropolitan sewer.

SECTION 2. To meet the expenses of determining the said location, as provided in section one, the treasurer and receiver general is authorized to issue scrip or certificates of debt in the name and on behalf of the Commonwealth, and under its seal, to an amount not exceeding seven thousand dollars in addition to the amounts authorized to be issued under the provisions of chapter four hundred and twenty- our of the acts of the year eighteen hundred and ninety-nine, and of chapter three hundred and fifty-six of the acts of the year nineteen hundred and three; and all the provisions of said acts shall apply to this additional loan. Treasurer and receiver general to issue scrip or certificates of debt, etc.

SECTION 3. This act shall take effect upon its passage. [*Approved April 12, 1904.*

[CHAPTER 246.]

AN ACT TO PROVIDE FOR EXPENSES INCURRED IN THE CONSTRUCTION OF THE HIGH LEVEL GRAVITY SEWER FOR THE RELIEF OF THE CHARLES AND NEPONSET RIVER VALLEYS.

Be it enacted, etc., as follows:

SECTION 1. The treasurer and receiver general of the Commonwealth, in order to meet additional expenses incurred under the provisions of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine, and chapter three hundred and fifty-six of the acts of the year nineteen hundred and three, shall, with the approval of the governor Treasurer and receiver general to issue scrip or certificates of debt, etc.

and council, issue from time to time scrip or certificates of debt in the name and behalf of the Commonwealth and under its seal, to an amount not exceeding three hundred and eighty-five thousand dollars, in addition to the amounts authorized to be issued under the provisions of said chapters; and the provisions of said chapters and of acts in amendment thereof and in addition thereto shall apply to this additional loan.

SECTION 2. This act shall take effect upon its passage. [*Approved April 22, 1904.*

[CHAPTER 273.]

AN ACT TO AUTHORIZE THE LAYING OF WATER PIPES OR MAINS UNDER OR OVER TIDE WATER.

Be it enacted, etc., as follows:

Certain water pipes or mains may be carried under or over tide waters, etc.

SECTION 1. The metropolitan water and sewerage board, and the water board, water commissioners or superintendent of any city or town in the metropolitan water district, in exercising the powers or discharging the duties conferred or imposed by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, may carry and conduct any aqueduct, conduit, pipe, drain or wire under or over tide waters or the waters of Boston harbor by such methods and in such manner as the board of harbor and land commissioners shall approve.

SECTION 2. This act shall take effect upon its passage. [*Approved April 29, 1904.*

[CHAPTER 299.]

AN ACT TO CONFIRM A CERTAIN AGREEMENT BETWEEN THE METROPOLITAN WATER AND SEWERAGE BOARD AND THE CITY OF MARLBOROUGH, RELATIVE TO BUILDING AN ADDITIONAL MAIN SEWER AND FILTER BEDS FOR SAID CITY.

Be it enacted, etc., as follows:

Certain agreement between city of Marlborough and metropolitan water and sewerage board confirmed.

SECTION 1. The agreement signed by the mayor of the city of Marlborough, for that city, and by the metropolitan water and sewerage board, for the Commonwealth, dated October five, nineteen hundred and three, and recorded with Middlesex south district registry of deeds, book 3091, page 101, providing for the construction and maintenance of an additional main sewer and filter beds for the disposal of a part of the sewage of said city, as a substitute for the additional main sewer provided

for by chapter four hundred and forty-three of the acts of the year nineteen hundred and three, is hereby ratified and confirmed; and all action taken, all construction work done and all payments made under said agreement in the construction of said additional main sewer and filter beds, are hereby ratified, approved and made valid, as fully as if such additional main sewer had been constructed in accordance with the provisions of said chapter.

SECTION 2. This act shall take effect upon its passage. [*Approved May 6, 1904.*

[CHAPTER 311.]

AN ACT RELATIVE TO THE EMPLOYMENT OF MECHANICS AND LABORERS IN THE CONSTRUCTION OF PUBLIC WORKS.

Be it enacted, etc., as follows:

R. L. 106, § 14, amended.

Chapter one hundred and six of the Revised Laws is hereby amended by striking out section fourteen and inserting in place thereof the following: — *Section 14.* In the employment of mechanics and laborers in the construction of public works by the Commonwealth, or by a county, city or town, or by persons contracting therewith, preference shall be given to citizens of the Commonwealth, and, if they cannot be had in sufficient numbers, then to citizens of the United States; and every contract for such works shall contain a provision to this effect. Any contractor who knowingly and wilfully violates the provisions of this section shall be punished by a fine of not more than one hundred dollars for each offence. [*Approved May 9, 1904.*

Preference to be given to citizens in the employment of mechanics and laborers.

Penalty.

[CHAPTER 314.]

AN ACT TO REGULATE REMOVALS AND SUSPENSIONS FROM OFFICE AND EMPLOYMENT IN THE CLASSIFIED CIVIL SERVICE.

Be it enacted, etc., as follows:

SECTION 1. Every person holding office or employment in the public service of the Commonwealth or in any county, city or town thereof, classified under the civil service rules of the Commonwealth, shall hold such office or employment and shall not be removed therefrom, lowered in rank or compensation, or suspended, or, without his consent, transferred from such office or employment to any other except for just cause and for reasons specifically given in writing.

Persons holding office in the public service not to be removed, etc., without cause.

Notice to be given, etc.

SECTION 2. The person sought to be removed, suspended, lowered or transferred shall be notified of the proposed action and shall be furnished with a copy of the reasons required to be given by section one, and shall, if he so requests in writing, be given a public hearing, and be allowed to answer the charges preferred against him either personally or by counsel. A copy of such reasons, notice and answer and of the order of removal, suspension or transfer shall be made a matter of public record. [*Approved May 9, 1904.*

[CHAPTER 317.]

AN ACT RELATIVE TO DAMAGES FOR THE TAKING OF PROPERTY BY RIGHT OF EMINENT DOMAIN.

Be it enacted, etc., as follows:

Payment of damages for the taking of property by right of eminent domain, etc.

SECTION 1. In all cases of property, real or personal, taken by right of eminent domain, or subjected to restrictions, limitations or regulations by the Commonwealth, or by any county, city or town therein, the Commonwealth or such county, city or town may, at any time after such taking, or after the imposition of such restrictions, limitations or regulations, estimate and award to any person, city, town or corporation injured by such taking or by such imposition, the damages recoverable therefor, and may offer in writing to pay to such person, city, town or corporation the amount of such award, with interest thereon, as provided by law, from the date of such taking or such imposition, together with taxable costs if a petition or other proceeding for assessment of such damages is pending. The person, city, town or corporation to whom or to which such offer is made, may reject or accept the same, and acceptance thereof may be either in full satisfaction of all damages so sustained, or as a payment *pro tanto* without prejudice to any right to have said damages assessed by a jury or other competent tribunal. After notice of such offer, made as aforesaid, or payment of the amount thereof, if payment be made, no interest shall be recoverable, except upon such amount in damages as shall, upon final adjudication, be in excess of the amount of said offer:

Proviso.

provided, that all taxable costs accruing subsequently to said offer shall be recoverable by the petitioner in all cases.

SECTION 2. This act shall take effect upon its passage. [*Approved May 9, 1904.*

[Chapter 349.]

An Act to provide for the protection of persons furnishing materials or labor for public works.

Be it enacted, etc., as follows:

Section 1. Officers or agents who contract in behalf of any county, city or town for the construction or repair of public buildings or other public works shall obtain sufficient security, by bond or otherwise, for payment by the contractor and subcontractors for labor performed or furnished and for materials used in such construction or repair; but in order to obtain the benefit of such security the claimant shall file with such officers or agents a sworn statement of his claim within sixty days after the completion of the work.

Protection of persons furnishing materials or labor for public works.

Section 2. This act shall take effect upon its passage. [*Approved May 19, 1904.*

[Chapter 383.]

An Act relative to printing and binding certain public documents.

Be it enacted, etc., as follows:

. . . .

Section 2. Boards, commissions and heads of departments having charge of preparing and printing documents relating to their various departments shall not incorporate therein any statistics unless the same shall be approved by the state board of publication.

Statistics not to be printed in public documents without approval of board of publication.

Section 3. This act shall take effect upon its passage. [*Approved May 31, 1904.*

[Chapter 406.]

An Act to provide for the improvement of Spot Pond brook by the metropolitan water and sewerage board.

Be it enacted, etc., as follows:

Section 1. The metropolitan water and sewerage board shall improve or change the channel of Spot Pond brook between Spot pond in the town of Stoneham and tide water in the city of Malden substantially in accordance with the plans and recommendations of the board contained in its report to the general court of nineteen hundred and three, being house document number one thousand and eighty-seven of that year.

The metropolitan water and sewerage board to improve Spot Pond brook, etc.

May take lands, easements, etc.

SECTION 2. The board, for the purpose aforesaid, may from time to time take, in fee or otherwise, by purchase or otherwise, for the Commonwealth or for the city of Malden or for the city of Melrose, as the board shall determine, lands, easements, rights and other property, and, in order to take any property by right of eminent domain, shall sign and cause to be recorded in the registry of deeds for the county and district in which the property to be taken is situated a description thereof as certain as is required in a common conveyance of land; the recording shall constitute the taking.

Damages.

SECTION 3. Any person whose property is injured by the taking, or by changing the channel of said brook, altering its course, or diverting the waters thereof or increasing or diminishing the daily flow of said waters, may have compensation therefor as determined by agreement with the board, and if the parties cannot agree upon the damages, they may be determined by a jury of the superior court for the county in which the property is situated under the provisions, so far as they may be applicable, of chapter forty-eight of the Revised Laws, upon petition therefor by the board or person filed in the clerk's office of the court within one year after the taking, changing or altering, and the petitioner shall have judgment for the amount determined, with interest on the excess of the amount over the award of the board and costs if the amount is greater than the award of the board; otherwise the petitioner shall recover no interest and shall pay costs.

Commissioners to be appointed, powers and duties.

SECTION 4. Any justice of the supreme judicial court sitting in equity for the county of Suffolk, on application of the metropolitan water and sewerage board or of the city of Malden or of the city of Melrose, within three months after the passage of this act, shall, after such notice as the court shall order, appoint three commissioners, and may appoint a new commissioner on the occurring of any vacancy. The commissioners, after such notice as they shall deem proper, shall hear the parties and make award of the proportion in which the expenses of carrying out this act shall be paid by the metropolitan water district, the city of Malden, and the city of Melrose. The commissioners shall take into consideration in making their award the responsibility of said parties in connection with the present condition of said brook and the waters thereof, their rights in, to and over said brook and the waters thereof, their rights in, to and over said Spot pond, its waters and watershed so far as they relate to said brook, and the benefits which will accrue to said parties

from the proposed improvements; and shall make their award on these bases and return it into court with a statement of the questions of law raised by either party and the findings of the commissioners thereon.

SECTION 5. Any justice of the said court sitting in equity for the county of Suffolk may accept the findings and award, and either party may except thereto; or the justice may report the case with such of said questions of law as either party may request to the supreme judicial court of the Commonwealth. Said court may determine the questions submitted and accept the award, or may amend and accept the award, or may remand the award to the commissioners for further hearing, report and acceptance, in accordance with said determination: *provided, however*, that if the city of Malden by vote of its city council, or the city of Melrose by vote of its city council, or the metropolitan water and sewerage board, shall, within four months after the acceptance of the award, file with the court objection to carrying on the work, it shall not be begun until the objection be withdrawn, but if no such objection be filed, or be filed and withdrawn within one year thereafter, the clerk of the court shall notify the parties thereof, and the work shall thereupon proceed as hereinbefore provided. The metropolitan water and sewerage board shall pay the compensation and expense of the commission as approved by the court, and during and after the completion of the work shall keep the channels, conduits and culverts in repair and pay the expense thereof, and the compensation and expenses so paid shall be assessed and repaid as the expense of construction is to be repaid.

Findings and award, etc.

Proviso.

Payment of compensation and expense of commission, etc.

SECTION 6. The other expenses incurred in carrying out the provisions of this act shall be paid by the Commonwealth, and the treasurer and receiver general shall, from time to time, on request of the board, issue and sell notes, bonds or scrip of the Commonwealth to an amount not exceeding two hundred and twenty-five thousand dollars, designated on the face thereof, Metropolitan Water Loan, and use the proceeds to meet said expenses and to meet the interest and sinking fund requirements of the loan until the award has been accepted, and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to said loan.

Metropolitan Water Loan.

Certain provisions of law to apply.

SECTION 7. The cities of Malden and Melrose shall respectively pay to the treasurer of the Commonwealth each year the

Payment of loan, etc.

interest and sinking fund requirements of such part of the loan aforesaid as shall be equal to the amount of said expenses which the cities respectively are required by the award to pay, and the interest and sinking fund requirements of the remainder of the loan shall be paid by all the cities and towns in the metropolitan water district, as other expenses of the water works are paid.

Assessment and collection of betterments.

SECTION 8. The commissioners shall, within six months after the completion of the work of construction, if in their opinion any land receives a benefit from the improvement authorized by this act beyond the general benefit to all land in said cities, determine the value thereof, and assess upon the land a proportional share of the cost of such improvement, not exceeding the value of the benefit; and any party so assessed may have the amount of the assessment determined by a jury of the superior court of the county in which the land is situated, under the provisions, so far as they may be applicable, of chapter fifty of the Revised Laws, but without interest or costs, if the assessment is not less than the amount determined by the jury, and the assessment shall constitute a lien upon the land assessed until paid. Every such assessment shall be certified by the clerk of said court to the collector of the city in which the land lies, and collected by him in the manner provided for the collection of taxes, and the proceeds thereof shall be paid to the treasurer of the Commonwealth and used to meet the interest and sinking fund requirements of the loan authorized by this act.

When to take effect.

SECTION 9. Except as otherwise provided herein this act shall take effect upon its passage. [*Approved June 3, 1904.*

[CHAPTER 410.]

AN ACT RELATIVE TO THE PRINTING AND DISTRIBUTION OF CERTAIN PUBLIC DOCUMENTS.

Be it enacted, etc., as follows:

R. L. 9, § 7, amended.

Section seven of chapter nine of the Revised Laws is hereby amended as follows: — . . . By striking out the words "forty-five hundred", in the one hundred and eighteenth line, and inserting in place thereof the words: — six thousand, — so that the paragraph beginning with the one hundred and eighteenth line will read as follows: — Of the metropolitan water and sewerage board, six thousand copies. [*Approved June 3, 1904.*

Report of metropolitan water and sewerage board.

[Chapter 426.]

An Act relative to the apportionment of the annual assessments required for the construction and maintenance of the metropolitan water system.

Be it enacted, etc., as follows:

The treasurer and receiver general of the Commonwealth, for the purpose of making the apportionment to the cities and towns in the metropolitan water district of the amount required in each year to pay the interest, sinking fund requirements and expenses of maintenance and operation of the metropolitan water system provided for by section nineteen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, as amended by chapter four hundred and eighty-nine of the acts of the year nineteen hundred and one, shall, in the year nineteen hundred and six and in each year thereafter, apportion to the city of Boston the proportion of such amount which the valuation of that city for the preceding year bears to the total of all such valuations of all cities and towns in said water district: *provided, however*, that there shall be included only one fifth of the total valuation of every such city and town which has not reached the safe capacity of its present sources of supply in a dry year or of the sources of supply of the water company by which it is supplied, as determined by the metropolitan water and sewerage board and certified to said treasurer, or which has not made application to said board for water; and the remainder to the other cities and towns in said district, one third in proportion to their respective valuations for the preceding year and the remaining two thirds in proportion to the consumption by the cities and towns respectively in the preceding year of water received from all sources of supply as determined by said board and certified to said treasurer, including however only one fifth of the total valuation and not including any consumption of water for any such city or town which has not reached the safe capacity of its present sources of supply or of the sources of supply of the water company by which it is supplied as aforesaid, or which has not made application to said board for water; and *provided, further*, that any city or town assessed upon its full valuation which obtains a part of its water supply from its own works or receives a supply from a water company shall be allowed and credited in its apportionment with a sum equal to twelve dollars for each million gallons of water furnished as aforesaid, as determined by said

Apportionment of annual assessments for construction and maintenance of the metropolitan water system.

Proviso.

Proviso.

Payment of assessments.

board and certified to said treasurer. The treasurer shall in each year notify each city and town of the amount of its assessment, and the same shall be paid by the city or town into the treasury of the Commonwealth at the time required for the payment and as part of its state tax. [*Approved June 4, 1904.*

[Chapter 431.]

AN ACT RELATIVE TO THE APPROVAL OF CERTAIN OFFICIAL BONDS.

Be it enacted, etc., as follows:

Approval of certain official bonds.

SECTION 1. The official bonds given by persons designated to receipt for advances of money by the metropolitan park commission and the metropolitan water and sewerage board, which have heretofore been approved by the auditor of accounts, shall hereafter be approved by the treasurer and receiver general.

SECTION 2. This act shall take effect upon its passage. [*Approved June 4, 1904.*

[Chapter 436.]

AN ACT RELATIVE TO COMPENSATION FOR DAMAGES OCCASIONED IN THE TOWN OF BOYLSTON BY THE CONSTRUCTION OF THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Compensation for damages occasioned in town of Boylston by the construction of the metropolitan water system.

SECTION 1. The owner of any real estate situated in that part of the town of Boylston on the southerly and southeasterly side of the metropolitan water basin known as the Wachusett reservoir, and within the limits of the Nashua river watershed, not taken but directly or indirectly decreased in value by reason of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and amendments thereof, entitled "An Act to provide for a metropolitan water supply", or by the doings of the metropolitan water board or of the metropolitan water and sewerage board thereunder, shall have the same right to damages for such decrease in value, to be determined and recovered in the same way, as is provided for owners of certain real estate in the town of West Boylston by section fourteen of said chapter: *provided*, that the petition required by said section is filed within two years after the passage of this act; but no owner shall have the right to surrender his real estate to the Commonwealth in the manner provided in said chapter.

Proviso.

Certain rules and regulations not to consti-

SECTION 2. The rules and regulations of the state board of health or of the metropolitan water and sewerage board now or

hereafter in force for the sanitary protection of water or sources of water supply shall not constitute an element of damage within the meaning of this act.

tute an element of damage.

SECTION 3. This act shall take effect upon its passage. [*Approved June 8, 1904.*

[CHAPTER 457.]

AN ACT TO AUTHORIZE THE TOWN OF REVERE TO SUPPLY ITSELF WITH WATER.

Be it enacted, etc., as follows:

SECTION 1. The town of Revere may supply itself, its inhabitants and such inhabitants of the town of Saugus as are now supplied with water or may hereafter make application to be supplied with water under the provisions of section seven of chapter three hundred and eighty-two of the acts of the year eighteen hundred and eighty-nine, with water for the extinguishment of fires and for domestic and other purposes, obtaining the same from the metropolitan water supply district, as provided in chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, may establish fountains and hydrants and relocate or discontinue the same, and may regulate the use of such water and fix and collect rates to be paid for the use of the same.

Town of Revere may supply itself, its inhabitants and certain inhabitants of Saugus with water.

May obtain water from metropolitan water supply.

May establish hydrants, etc., regulate the use of water, etc.

SECTION 2. Said town for the purposes aforesaid may hold and convey the water to be furnished by the metropolitan water supply district as hereinbefore provided, and may also take, by purchase or otherwise, and hold all lands, rights of way and easements necessary for holding, storing, purifying and preserving such water and for conveying the same to any part of said town; may erect on the lands thus taken or held proper dams, reservoirs, buildings, fixtures or other structures; may make excavations, procure and operate machinery, and provide such other means and appliances as may be necessary for the establishment and maintenance of complete and effective water works; may construct and lay conduits, pipes and other works, under and over any lands, water courses, railroads, railways or public or private ways, and along any such way in such manner as not unnecessarily to obstruct the same; and for the purpose of constructing, maintaining and repairing such conduits, pipes or other works, and for all proper purposes of this act, said town may dig up any such lands, and may enter upon and dig up any such ways in such manner as to cause the least hindrance

May hold and convey water furnished by metropolitan water supply district.

May take and hold lands, etc.

to public travel thereon. The title to all land taken or purchased under the provisions of this act shall vest in said town, and the land so taken may be managed, improved and controlled by the board of water commissioners hereinafter provided for, in such manner as they shall deem for the best interests of said town: *provided*, that nothing in this section shall be construed as authorizing said town to acquire, enter upon or make use of land of the Commonwealth in said town for said purposes, unless the consent of the officers of the Commonwealth having control of such land has first been obtained.

Proviso.

Land of Commonwealth not to be used, etc.

. . . .

Payment of loan, etc.

SECTION 6. The town shall provide at the time of contracting the loan for such annual proportionate payments thereof as will extinguish the same at maturity, and after the town has passed a vote to that effect the sums required for this purpose and for payment of interest on the loan shall be assessed and collected annually in the same manner in which other taxes are assessed and collected. The town shall also raise annually by taxation a sum which with the income derived from water rates will be sufficient to pay the current annual expenses of operating its water works, including therein any annual payment to said metropolitan water board.

Payment to metropolitan water board included.

. . . .

Powers and duties.

SECTION 10. Said commissioners shall fix such prices or rents for the use of water as shall produce annually as near as may be a net surplus over operating expenses, including therein any annual payment to said metropolitan water board, and interest charges equal to two per cent of the total amount of the bonds, notes or scrip issued under this act, after paying all current expenses of operating the water works, and interest upon loans, and after payment of all expenses of new construction not exceeding three thousand dollars in any one year after the original construction. The net surplus aforesaid shall be paid into the treasury of the town. Said commissioners shall annually render an account of all their doings, and shall be governed by the provisions of section fifteen of chapter twenty-seven of the Revised Laws and acts in amendment thereof and in addition thereto, except as otherwise provided herein.

Payment to metropolitan water board to be included in expense account.

. . . .

When to take effect, etc.

SECTION 12. This act shall be submitted to the voters of said town at any annual town meeting or at a special meeting duly called for the purpose, at which the check list shall be used, and it shall take effect upon its acceptance by two thirds of the voters present and voting thereon at any such meeting. If the

act is accepted at an annual town meeting, the water commissioners herein provided for may be elected at the same meeting. [*Approved June 9, 1904.*

RESOLVES.

[Chapter 28.]

RESOLVE TO PROVIDE FOR THE PAYMENT OF A SUM OF MONEY FROM THE METROPOLITAN SEWERAGE LOAN TO HANNAH M. McCARTHY.

Resolved, That there be allowed and paid out of the Metropolitan Sewerage Loan authorized by section fourteen of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine, the sum of seven hundred and fifty dollars, to Hannah M. McCarthy, widow of Patrick D. McCarthy who was killed on the twenty-sixth day of May in the year nineteen hundred and two by an accident in a metropolitan sewer in Roxbury, while in the discharge of his duties as an employee of the metropolitan water and sewerage board. [*Approved March 31, 1904.*

Hannah M. McCarthy.

[Chapter 98.]

RESOLVE TO PROVIDE FOR THE APPOINTMENT OF A COMMITTEE TO INVESTIGATE THE LOCAL SEWERAGE SYSTEMS WITHIN THE METROPOLITAN SEWERAGE DISTRICT.

Resolved, That the governor, with the advice and consent of the council, is hereby authorized to appoint a committee of three persons, of whom one shall be a member of the metropolitan park commission, one a member of the Charles River basin commission, and one a member of the board of harbor and land commissioners, and of whom one shall be designated by the governor as chairman. The said committee shall investigate the extent, condition and usefulness of the sewerage systems of the cities and towns within the metropolitan sewerage district, but not now included in the metropolitan sewerage system, and especially shall ascertain whether or not any parts of such local sewerage systems should, in their judgment, be purchased and maintained by the metropolitan water and sewerage board. The members of the committee shall serve without compensation, and shall report to the next general court on or before the fifteenth day of January in the year nineteen hundred and five. [*Approved June 3, 1904.*

Committee to investigate certain sewerage systems, etc., appointment, etc.

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